BUDGET JUSTIFICATIONS

The United States
Department of the Interior

and Performance Information
Fiscal Year 2011

U.S. GEOLOGICAL SURVEY

NOTICE: These budget justifications are prepared for the Interior, Environment and Related Agencies Appropriations Subcommittees. Approval for release of the justifications prior to their printing in the public record of the Subcommittee hearings may be obtained through the Office of Budget of the Department of the Interior.

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U.S. GEOLOGICAL SURVEY
FY 2011 BUDGET JUSTIFICATION

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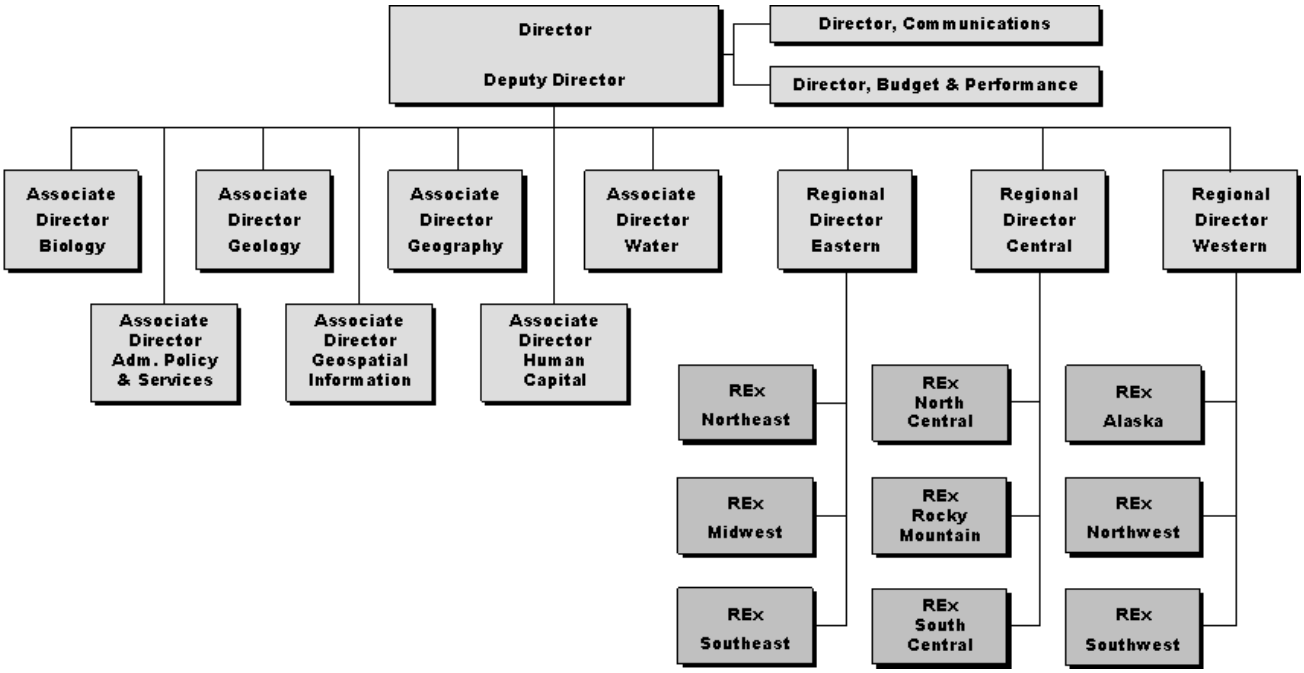
U.S. Geological Survey



USGS Regional Structure

Alphabetical List of Acronyms

AAAS	American Association for the Advancement of Science
AAPG	American Association of Petroleum Geologists
ABC	Activity-Based Costing
ABC/M	Activity-Based Costing/Management
ABP	Asset Business Plan
ACI	American Competitive Initiative
ACP	Artic Coastal Plain
ACWI	Advisory Committee on Water Information
ADA	Americans with Disabilities Act
AFS	American Fisheries Society
AFWA	U.S. Air Force Weather Agency
AMD	Aviation Management Directorate
AMP	Asset Management Plan
AMWG	Adaptive Management Work Group
ANS	Alaska North Slope
ANS	Aquatic Nuisance Species
ANSS	Advanced National Seismic System
ANWR	Arctic National Wildlife Refuge
APHIS	Agricultures Animal and Plant Health Inspection Service
API	Asset Priority Index
APS	Administration and Policy Services
AR	Accounts Receivable
ARMI	Amphibian Research and Monitoring Initiative
ARRA	American Recovery and Reinvestment Act
ASC	Alaska Science Center
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
AVHRR	Advanced Very High Resolution Radiometer
AVO	Alaska Volcano Observatory
AWiFS	Advanced Wide Field Sensor
BASIS+	Budget and Science Information System
BBL	Bird Banding Laboratory
BBS	Bird Breeding Survey
BEN	Balkan Endemic Nephropathy
BF&E	Budget Formulation and Execution Team
BGN	Board of Geographic Names
BIA	Bureau of Indian Affairs
BIMD	Biological Information Management and Delivery
BIS	Commerce - Bureau of Industry and Security
BLM	Bureau of Land Management
BLT	Business Leaders Team
BMPs	Best Management Practices
BNP	Biscayne National Park
BOR	Bureau of Reclamation
BPC	Bureau Program Council
BPXA	BP Exploration (Alaska)
BRD	Biological Resources Discipline
BRM	Biological Research and Monitoring
BSR	Business Strategy Review
CA	Condition Assessment

CAC	Civil Applications Committee
CALFED	California Federal (Bay-Delta Authority program)
CAP	Cooperative Agreements Program
CARA	Circum-Arctic Resource Appraisal
C&A	Certification and Accreditation
CC	Cost Center
CBERS	China/Brazil Earth Resources Satellite
CBLCM	Chesapeake Bay Land Cover Management
CBM	Coal bed Methane
CBP	Chesapeake Bay Program
CCI	Collaborative Communications Infrastructure
CCOAT	Coast Chesapeake Online Assessment Tool
CCSP	U.S. Climate Change Science Program
CDC	Centers for Disease Control and Prevention
CDR	Critical Design Review
CDI	Council for Data Integration
CEN	Climate Effects Network
CENR	Committee on Environment and Natural Resources
CEAP	Conservation Effects Assessment Project
CEGIS	Center of Excellence for Geographic Information Science
CEOS	Committee on Earth Observation Satellites
CEQ/NSTC	Council on Environmental Quality/National Science and Technology Council
CERC	Columbia Environmental Research Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERP	Comprehensive Everglades Restoration Plan
CESU	Cooperative Ecosystems Study Unit
CFO	Chief Financial Officer
CISN	California Integrated Seismic Network
CITES	Conventional on International Trade in Endangered Species
CMG	Coastal and Marine Geology
CMGP	Coastal and Marine Geology Program
CMSP	Coastal and Marine Spatial Planning
CNS	Central portion of the North Slope
CO_2	Carbon Dioxide
COAST	Chesapeake Online Adaptive Support Toolkit
CoML	U.S. National Committee for the Census of Marine Life
CORE	Committee on Resource Evaluation
CPIC	Capital Planning and Investment Control
CR	Central Region
CRADA	Cooperative Research and Development Agreement
CRSSP	Commercial Remote Sensing Space Policy
CRTF	Coral Reef Task Force
CRU	Cooperative Research Units
CRUISE	Columbia River USGS Integrated Science Explorer
CRV	Current Replacement Value
CRWA	Charles River Watershed Association
CSIRC	Computer Security Incident Response Capability
CSMP	California Seafloor Mapping Program
CSRS	Civil Service Retirement System
CTBTO	Comprehensive Test Ban Treaty Organization

CTM	Cooperative Topographic Mapping
CUES	Comprehensive Urban Ecosystems Studies
CUSEC	Central United States Earthquake Consortium
CVJV	Central Habitat Joint Venture
CVO	Cascades Volcano Observatory
CWD	Chronic Wasting Disease
CWP	Cooperative Water Program
CWS	Canadian Wildlife Service
DCIA	Debt Collection Improvement Act
DEM	Digital Elevation Model
DEP	[State] Department of Environmental Protection
DEQ	[State] Department of Environmental Quality
DFRs	Departmental Functional Reviews
DGH	Indian Directorate General of Hydrocarbons
DHS	Department of Homeland Security
DiGIR	Distributed Generic Information Retrieval
DMC	Data Management Center
DMC	Disaster Monitoring Constellation
DMCI	Deferred Maintenance and Capital Improvements
DNR	Department of Natural Resources
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOGAMI	Oregon Department of Geology and Mineral Industries
DPAS	Data Processing and Archiving
DRAGON	Delta Research and Global Observation Network
DROT	Drift River Oil Terminal
DRTO	Dry Tortugas National Park
DSS	Decision Support System
EA	Enterprise Architecture
EAD	Enterprise Active Directory
EAL	Energy Analytical Laboratory
ECMs	Energy Conservation Measures
ECO	Energy Conserving Opportunities
ECS	[U.S.] Extended Continental Shelf
EDCs	Endocrine Disrupting Chemicals
EDEN	Everglades Depth Estimation Network
EDMAP	Education Mapping Program (in National Cooperative Geologic Mapping Program)
EDRR	Early Detection, Rapid Assessment and Response
EEOC	Equal Employment Opportunity Commission
EFT	Electronic Funds Transfer
EGIM	Enterprise Geographic Information Management
EGS	Enhanced Geothermal Systems
EHP	Earthquake Hazards Program
EHP	Enterprise Hosting Platform
EI	Enterprise Information
EIR	Enterprise Information Resources
EISA	Energy Independence and Security Act of 2007
EIS&T	Enterprise Information Security and Technology
ELA	Enterprise License Agreement
ELT	Executive Leadership Team

EMS	Environmental Management System
E.O.	Executive Order
EOL	Encyclopedia of Life
EOP	Executive Office of the President
EPA	U.S. Environmental Protection Agency
EPCA	Energy Policy and Conservation Act of 2000
EPM	Ecosystem Portfolio Model
EPN	Enterprise Publishing Network
ER	Eastern Region
ERA	E-Risk Assessment
ERAS	eRemote Access Services
EROS	Earth Resources Observation and Science
ERP	Energy Resources Program
ESD	Earth Surface Dynamics
ESN	Enterprise Services Network
ESRI	Environmental Systems Research Institute
ET	Evapotranspiration
ETM+	Enhanced Thematic Mapper Plus
EVMS	Earned Value Management System
FAA	Federal Aviation Administration
FAC	Federal Advisory Committee
FACA	Federal Advisory Committee Act
FAER	Fisheries: Aquatic and Endangered Resources
FASAB	Federal Accounting Standards Advisory Board
FBAT	Facilities Budget Allocation Team
FBMS	Financial Business Management System
FBWT	Fund Balance with Treasury
FCI	Facilities Condition Index
FEA	Federal Enterprise Architecture
FECA	Federal Employee Compensation Act
FEDMAP	Federal lands Mapping Program (in National Cooperative Geologic Mapping Program)
FEGLI	Federal Employees Group Life Insurance
FEHB	Federal Employees Health Benefit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FERS	Federal Employees Retirement System
FFMIA	Federal Financial Management Improvement Act of 1996
FFS	Fire and Fire Surrogate
FGDC	Federal Geographic Data Committee
FICA	Federal Insurance Contributions Act
FICMNEW	Federal Interagency Committee for the Management of Noxious and Exotic Weeds
FISC	Florida Integrated Science Center
FISMA	Federal Information Security Management Act
FMT	Field Managers Team
FMFIA	Federal Managers' Financial Integrity Act of 1982
FMMS	Facilities Maintenance Management System
FOS	Flight Operations Segment
FOT	Flight Operations Team
FRAMES	Fire Research and Management Exchange System
FRB	Federal Reserve Board

FRPC	Federal Real Property Council
FRPP	Federal Real Property Profile
FSA	Farm Service Agency
FSAM	Federal Segment Architecture Methodology
FTE	Full-Time Equivalent
FWS	U.S. Fish and Wildlife Service
GAAP	Generally Accepted Accounting Principles
GAM	Geographic Analysis and Monitoring Program
GAP	Gap Analysis Program
GAO	Government Accountability Office
GBIP	Great Basin Information Project
GBIS	Global Biodiversity Information Facility
GCDAMP	Glen Canyon Dam Adaptive Management Program
GC-IMS	Global Change-Information Management System
GCP	Global Change Program
GCMRC	Grand Canyon Monitoring and Research Center
GEO	Group on Earth Observations
GEODE	GEO-Data Explorer
GeoMAC	Geospatial Multi-Agency Coordination Group
GEOSS	Global Earth Observation System of Systems
GFDL	Geophysical Fluid Dynamics Laboratory
GFL	Global Fiducials Library
GIO	Geographic Information Office
GIS	Geographic Information System
GLS	Global Land Survey
GLSC	Great Lakes Science Center
GNIS	Geographic Names Information System
GOES	Geostationary Operational Environmental Satellites
GOS	Geospatial One-Stop
GPRA	Government Performance and Results Act
GRB	Green River Basin
GPS	Global Positioning System
GPSC	Geospatial Products and Services Contract
GSA	General Services Administration
GS-FLOW	Groundwater and Surface-water flow model
GSN	Global Seismographic Network
GWRP	Ground-Water Resources Program
HAZUS	Federal Emergency Management Agency's Earthquake Loss Estimation Program
HBN	USGS Hydrologic Benchmark Network
HDOA	Hawaii Department of Agriculture
HDR	High-Data Rate Radio
HEDDS	Highly Pathogenic Avian Influenza Early Detection Data System
HHS	Department of Health and Human Services
HIF	Hydrologic Instrumentation Facility
HLI	Healthy Lands Initiative
HNA	Hydrologic Networks and Analysis Program
HPO	High Performing Organization
HPPG	High Priority Performance Goal
HR	Human Resources
HR&D	Hydrologic Research and Development Program

HRS	Helibourne electromagnetic Surveys
HSPD -12	Homeland Security Presidential Directive 12
HUD	US Department of Housing and Urban Development
HVO	Hawaii Volcano Observatory
HWATT	Hemlock Woolly Adelgid Action Team
I&M	Inventory and Monitoring – NPS
IAGA	International Association of Geomagnetism and Aeronomy
ICAO	International Civil Authorization Organization
ICL	International Consortium on Landslides
ICRP	Internal Control Review Plan
ICWP	Interstate Council on Water Policy
IDWR	Idaho Department of Water Resources
IEAM	Integrated Environmental Assessment and Management
IGPP	Institute for Geophysics and Planetary Physics
IIE	Integrated Information Environment
ILM	Integrated Landscape Monitoring
IOOS	Integrated Ocean and coastal Observing System
IP	Investment Plan
IPCC	Intergovernmental Panel on Climate Change
IPDS	Information Product Data System
IRB	Investment Review Board
IRIS	Incorporated Research Institutions for Seismology
IRS	Indian Remote Sensing Satellite
InSAR	Interferometric Synthetic Aperture Radar
ISO	International Organization for Standardization
ISSP	Information Security Strategic Plan
IT	Information Technology
ITAP	Invasive Terrestrial Animals and Plants
ITILOB	Information Technology Infrastructure Line of Business
ITIS	Integrated Taxonomic Information System
ITSOT	IT Security Operations Team
ITSSC	IT Security Steering Committee
IUCN	International Union for the Conservation of Nature
IUCN	International Union of Conservation Nations
JFA	Joint Funding Agreement
JV	Joint Venture Partnerships
KSF	Thousand Square Feet
LAS	Local Action Strategy
LCAT	Land Cover Analysis Tool
LCC	Landscape Conservation Cooperatives
LDCM	Landsat Data Continuity Mission
LDGST	Landsat Data GAP Study Team
LEAG	Long-term Estuary Assessment Group
LHP	Landslide Hazards Program
LiDAR	Light Detecting and Ranging
LIFE	NBII Library of Images from the Environment
LIMA	Landsat Image Mosaic of Antarctica
LMV	Lower Mississippi Valley
LMVJV	Lower Mississippi Valley Joint Venture Office
LOA	Level of Authentication

LRS	Land Remote Sensing
LST	Landsat Science Team
LTRMP	Long-Term Resource Monitoring Program
LTWG	Landsat Technical Working Group
LUPM	Land Use Portfolio Model
MARCO	Mid-Atlantic Research Consortium for Oceanography
Mbtu	Million British thermal units
MD	Management Directive
MEO	Most Effective Organization
METRIC	Mapping EvapoTranspiration with high Resolution and Internalized Calibration
MHDP	Multi-Hazards Demonstration Project
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MOC	Mission Operations Center
MODIS	Moderate Resolution Imaging Spectroradiometer
MODFLOW	Modular Ground-Water Flow Model
MOU	Memorandum of Understanding
MRBI	Mississippi River Basin Healthy Watersheds Initiative
MRDS	Mineral Resources Data System
MRERP	Mineral Resources External Research Program
MRLC	Multi-Resolution Land Characteristics Consortium
MRP	Mineral Resources Program
MSCP	Multi-Species Conservation Program
MSH	Mount St. Helens
MSS	Multi Spectral Scanner
MTBE	methyl tert-butyl ether
MUSIC	MIT-USGS Science Impact Collaborative
MW	Megawatt
MWe	Megawatt electric
NABCI	North American Bird Conservation Initiative
NACO	National Association of Counties
NADP	National Atmospheric Deposition Program
NANPCA	Non-indigenous Aquatic Nuisance Prevention and Control Act
NARA	National Archives and Records Administration
NAS	National Academy of Sciences
NAS	USGS National Non-indigenous Aquatic Species Database
NASA	National Aeronautics and Space Administration
NASQAN	National Stream Quality Accounting Network
NAWQA	National Water-Quality Assessment
NBC	Department of the Interior – National Business Center
NBII	National Biological Information Infrastructure
NCAR	National Center for Atmospheric Research
NCAP	National Civil Applications Program
NCCWSC	National Climate Change and Wildlife Science Center
NCDE	Northern Continental Divide Ecosystem
NCEP/NOAA	National Centers for Environmental Prediction
NCGMP	National Cooperative Geologic Mapping Program
NCIA	National Competitiveness Investment Act
NCPP	USGS National Coastal Program Plan
NCRDS	National Coal Resources Data System

NDMC	National Drought Mitigation Center
NDOP	National Digital Orthoimagery Program
NED	National Elevation Dataset
NEHRP	National Earthquake Hazards Reduction Program
NEIC	National Earthquake Information Center
NEON	National Ecological Observatory Network
NEPA	National Environmental Policy Act
NEST	National Environmental Status and Trends
NETL	National Energy Technology Laboratory
NFHAP	National Fish Habitat Action Plan
NGA	National Geospatial-Intelligence Agency
NGAC	National Geospatial Advisory Committee
NGGDPP	National Geological and Geophysical Data Preservation Program
NGIC	National Geomagnetic Information Center
NGMDP	National Geologic Map Database Project
NGO	Nongovernmental organization
NGP	National Geospatial Program
NGTOC	National Geospatial Technical Operations Center
NGWMN	National Ground Water Monitoring Network
NHD	National Hydrography Dataset
NHWC	National Hydrologic Warning Council
NIEHS	National Institute of Environmental Health Sciences
NIFC	National Interagency Fire Center
NIH	National Institute of Health
NISC	National Invasive Species Council
NIISS	National Institute for Invasive Species Science
NIST	National Institute of Standards and Technology
NIWR	National Institutes for Water Resources
NLC	National League of Cities
NLCD	National Land Cover Database
NLIC	National Landslide Information Center
NLIP	National Land Imaging Program
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NORTHCOM	U.S. Northern Command
NOSC	National Operations and Security Center
NPN	National Phenology Network
NPRA	National Petroleum Reserve Alaska
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NRIS	Natural Resource Information System
NRC	National Research Council
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRMP	National Resource Monitoring Partnership
NROC	Northeast Regional Ocean Council
NRP	National Research Program (research organization in USGS Water discipline)
NRPP	National Resource Preservation Program
NSDI	National Spatial Data Infrastructure
NSF	National Science Foundation

NSGIC	National States Geographic Information Council
NSIP	National Streamflow Information Program
NSLRSDA	National Satellite Land Remote Sensing Data Archive
NSMP	National Strong Motion Program
NSPD	National Space Policy
NSTC	National Science and Technology Council
NSVRC	Northern Shenandoah Valley Regional Commission
NTN	National Trends Network
NVCS	National Vegetation Classification Standard
NVEWS	National Volcano Early Warning System
NWAVU	National Water Availability and Use Assessment
NWHC	National Wildlife Health Center
NWIS	National Water Information System
NWQL	National Water Quality Laboratory
NWQMN	National Water Quality Monitoring Network
NWS	National Weather Service
O&M	Operations and Maintenance
OAFM	USGS Office of Accounting and Financial Management
OAG	USGS Office of Acquisition and Grants
OAP	Ocean Action Plan
OBIS	Ocean Biogeographic Information System
OBIS	USGS Office of Business Information Systems
OBP	USGS Office of Budget and Performance
OC	USGS Office of Communications
OEPC	Office of Environmental Policy and Compliance
OES	Office of Emergency Services
OFDA	Office of Foreign Disaster Assistance
OFEE	Office of the Federal Environmental Executive
OFR	Open-File Report
OGC	Open Geospatial Consortium
OHC	USGS Office of Human Capital
OIA	Office of Insular Affairs
OICR	USGS Office of Internal Control and Reporting
OIG	Office of the Inspector General
OGDB	Organic Geochemistry Database
OLI	Operational Land Imager
OMB	Office of Management and Budget
OMS	USGS Office of Management Services
OPA	USGS Office of Policy and Analysis
OPM	Office of Personnel Management
ORPP	Ocean Research Priority Plan
ORPPIS	Ocean Research and Priorities Plan and Implementation Strategy
OSHA	Occupational Safety and Health Administration
OSM	Office of Surface Mining
OSTP	Office of Science and Technology Policy
OWRS	Office of Western Regional Services
PAGER	Prompt Assessment of Global Earthquakes for Response
PAR	Performance and Accountability Report
PBO	Plate Boundary Observatory
PBX	Private Branch eXchange

PCR	Polymerase Chain Reaction
PDA	Personal Digital Assistant
PDF	Portable Document Format
PDR	Preliminary Design Review
PES	Priority Ecosystem Science
PFM	(Department) Office of Financial Management
PI	Principal Investigator
PII	Personally Identifiable Information
PIP	Performance Improvement Plan
PIP	Program Improvement Plan
PMO	Project Management Office
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
POA&M	Plan of Action and Milestone
PP&E	Property, Plant, and Equipment
PPM	Planning Performance Management
P&PM	Planning and Performance Management Team
PRB	Powder River Basin
PSNER	Puget Sound Near Shore Ecosystem Restoration
PSS	Perimeter Security Standard
PTWC	Pacific Tsunami Warning Center
PWRC	Patuxent Wildlife Research Center
QOL	Quality of Life
R&D	Research and Development
RASA	Regional Aquifer-System Analysis
RCCRC	Regional Climate Change Response Centers
RCM	Regional Climate Models
RCOOS	Regional Coastal Ocean Observing Systems
REMS	River Ecosystem and Modeling Science
RFP	Request for Proposal
RGIO	Regional Geospatial Information Office®
RIF	Reduction in Force
RIM	River Input Monitoring Program
RISA	Regional Integrated Science and Assessments – NOAA
RPM	Real Property Management System
RSSC	Reston Supply Service Center
RSSI	Required Supplementary Stewardship Information
RTS	Reports Tracking System (Water Resources)
R/V	Research Vessel
RWRPC	Regional Water Resources Policy Committee
S&T	USGS Status and Trends of Biological Resources program
SAC	USGS Science Advisory Council
SAFOD	San Andreas Fault Observatory at Depth
SAIN	Southern Appalachian Information Node
SAP	Synthesis and Assessment Product
SAR	Synthetic Aperture Radar
SAUs	Storage Assessment Units
SBFD	San Francisco Bay and freshwater delta
SBSP	South Bay Salt Pond Restoration Project
SCEC	Southern California Earthquake Center
SCR	System Concept Review

SDI	Spatial Data Infrastructures
SDR	Subcommittee for Disaster Reductions
SDRT	Supervisory Development Review Team
SES	Senior Executive Service
SETAC	Society of Environmental Toxicology and Chemistry
SFBD	San Francisco Bay Delta
SFWMD	South Florida Water Management District
SHC	Strategic Habitat Conservation
SLC	Scan Line Corrector
SGL	Standard General Ledger
SIR	Surveys, Investigations, and Research
SOGW	Subcommittee of Ground Water
SoIVES	Social Values for Ecosystem Services
SOW	Statement of Work
SPARROW	Spatially Referenced Regressions on Watershed Attributes
SPOC	Security Point of Contact
SPOT	Satellite Pour L'Observation de la Terre
SPRESO	South Pole Remote Earth Science Observatory
SRR	Systems Requirement Review
SRTM	Shuttle Radar Topographic Mission
SSRIs	Selective Seronin Reuptake Inhibitors
STATEMAP	State Mapping Program (in Cooperative Geologic Mapping Program)
STIG	Security Technical Implementation Guides
SWAQ	Subcommittee on Water Availability and Quality
SWPC	Space Weather Prediction Center
TAA	Technical Assistance Agreements
TANC	Transport of Anthropogenic and Natural Contaminants
TCOM	Tahoe Constrained Optimization Model
TDWG	Biodiversity Information Standards
TIC	Trusted Internet Connection
TIRS	Thermal Infrared Sensor
TM	Thermatic Mapper
TMDL	Total Maximum Daily Loads (Clean Water Act requirement)
TRIGRS	Transient Rainfall Infiltration and Grid-Based Regional Slope-Stability Analysis
TRIP	The Road Indicator Project
TROR	Treasury Report on Receivables
TRPA	Tahoe Regional Planning Agency
TSP	Thrift Savings Plan
UAS	Unmanned Aerial Systems
UHM	University of Hawaii-Manoa
UIC	Underground Injection Control
URISA	Urban and Regional Information System Association
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAID	U.S. Agency for International Development
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USDOE	U.S. Department of Energy
USFS	U.S. Forest Service
USGCRP	U.S. Global Change Research Program

USGEO	U.S. Group on Earth Observations
USGS	U.S. Geological Survey
UMESC	Upper Midwest Environmental Services Center
USNG	United States Nation Grid
VANS	Volcano Activity Notices
VBNS	Very Broadband Network Services
VCP	Vegetation Characterization Program
VDAP	Volcano Disaster Assistance Program
Veg	Vegetation Characterization
VegDRI	Vegetation Drought Response Index
VHP	Volcano Hazards Program
VHSV	Viral Hemorrhagic Septicemia Virus
VOIP	Voice over IP Systems
VONA	Volcano Observatory Notifications for Aviation
VSIP/VERA	Voluntary Separation Incentive Payment/Voluntary Early Retirement Authority
WAN	Wide Area Network
WCCI	Wyoming Cooperative Conservation Initiative
WCF	Working Capital Fund
WCMC	UNEP-World Conservation Monitoring Center
WFRC	Western Fisheries Research Center
WLCI	Wyoming Landscape Conservation Initiative
WNS	White-Nose Syndrome
WNV	West Nile Virus
WPA	World Petroleum Assessment 2000
WR	Western Region
WRD	Water Resources Discipline
WRIR	Water Resources Investigation Report
WRRA	Water Resources Research Act
WRRIs	[State] Water Resources Research Institutes
WSC	[USGS State] Water Science Center
WSWC	Western States Water Council
WTER	Wildlife: Terrestrial and Endangered Resources
WUI	Wildland-Urban Interface
YMP	Yucca Mountain Program
YVO	Yellowstone Volcano Observatory

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General Statement

Total 2011 Budget Request
(Dollars in Thousands)

Budget Authority	2009 Actual	2009 Recovery Act	2010 Enacted	2011 Budget Request	Change 2011 from 2010
Discretionary	1,043,803	140,000	1,111,740	1,133,359	21,619
Mandatory	2,221		1,521	1,028	-493
Total	**1,046,024**	**140,000**	**1,113,261**	**1,134,387**	**21,126**
FTEs 1/ 2/	*8,472*	*10*	*8,596*	*8,538*	*-58*

FTEs	2009 Actual	2009 Recovery Act	2010 Enacted	2011 Budget Request	Change 2011 from 2010
Direct/Appropriated	5,351		5,445	5,434	-11
Reimbursable	2,812		2,812	2,798	-14
Working Capital Fund	285		284	282	-2
Contributed Funds	7		7	7	0
Allocation Accounts	17		17	17	0
ARRA Direct		9	30	0	-30
ARRA Reimbursable		1	1	0	-1
Total 1/ 2/	8,472	10	8,596	8,538	-58

1/ 2010 FTE estimates include the net impact of changes due to additional Recovery Act hiring, delayed hiring to fill 2009 vacancies, and proposed program changes in 2010.

2/ 2011 FTE estimates include the net impact of changes due to separations following completion of Recovery Act activities and proposed program changes in 2011.

2010 Budget Request by Interior Goal
(Dollars in Thousands)

Improve Understanding	2009 Actual	2009 Recovery Act	2010 Enacted	2011 Budget Request	Change 2011 from 2010
National Ecosystems and Resources	830,731	81,854	893,461	913,159	19,698
Energy and Mineral Resources	99,378	6,293	102,426	103,946	1,520
Natural Hazards	113,694	51,853	115,853	116,254	401
Total	**1,043,803**	**140,000**	**1,111,740**	**1,133,359**	**21,619**

Introduction

Since March 3, 1879, the U.S. Geological Survey (USGS) has provided the United States with science information needed to make important land use and management.

The USGS is the Earth and natural science research bureau for the Department of the Interior (Interior) and the only integrated natural resources research agency in the Federal Government. USGS research and data products support Interior's resource and land management needs, and also provide the water, biological, energy, and mineral resources information needed by other Federal, State, Tribal, and local government agencies to guide planning, management, and regulatory programs. Emergency response organizations, natural resource managers, land use planners, and other customers use this information to protect lives and property and to make informed decisions based on the application of science. Natural resource and environmental managers apply USGS science research in answering public health questions and in promoting public prosperity for the future well being of our country.

The USGS conducts research, monitoring, and assessments to contribute to understanding the natural world—America's lands, water, and biological resources. The USGS provides reliable, impartial information to the citizens of this country and to the global community in the form of maps, data, and reports containing analyses and interpretations of water, energy, mineral, and biological resources; land surfaces; marine environments; geologic structures; natural hazards; and dynamic processes of the Earth. USGS data and information are used daily by managers, planners, and citizens to understand, respond to, and plan for changes in the environment.

Overview

The 2011 request for the USGS is $1.1 billion in current appropriations, an increase of $21.6 million from the 2010 Enacted Appropriation. The 2011 budget advances Administration and Secretarial priorities including:

- New Energy Frontier,
- Climate Change Adaptation,
- WaterSMART Program,
- Youth in Natural Resources, and
- Treasured Landscapes

In making funding and priority decisions, the USGS considered the following criteria in weighing the value of the science: interdisciplinary conduct and application, collaboration and partnerships, results of program evaluations, demonstration of progress toward advancing the USGS Science Strategy, and research and development investment criteria—performance, quality, and relevance.

The USGS is a valuable source of research and information for the American public. Under the proposed budget, the USGS will continue to:

- Work closely with Interior bureaus to ensure that their science and information needs are an integral part of USGS science plans;
- Carry out large-scale investigations on a regional and national basis that build the base of knowledge about the Earth;

- Apply multi-disciplinary scientific expertise in the fields of biology, geography, geology, hydrology, and geospatial information;
- Sustain long-term monitoring and assessment of natural resources;
- Collect, monitor, and analyze data and provide scientific understanding about natural resource conditions, issues, and problems; and
- Provide relevant, timely, impartial, and peer-reviewed natural resource information products.

These combined efforts, coupled with a mission independent of regulatory or land management activities, position the USGS as a leader in understanding complex natural science questions of the day; performing objective analyses; and providing scientific products that assist in developing solutions to land management challenges. For more than a century, natural resource managers, emergency response organizations, land use planners, decisionmakers at all levels of government, and citizens in all walks of life have come to depend on the USGS for reliable unbiased information to use as tools to address societal issues related to public safety and health, natural resource management, and environmental understanding and protection.

2011 Major Focus

The 2011 budget request focuses on Secretarial Initiatives in New Energy Frontier, Climate Change Adaptation, WaterSMART Program, and Treasured Landscapes. See Section E, Secretarial Initiatives and Mission Increases for details on these initiatives. The 2011 budget request is based on the 2010 Enacted Appropriations. Secretarial Initiatives are funded at $26,614,000. Other increases include $4,000,000 to increase resilience to natural hazards, $13,350,000 for the continuation of Landsat Data Continuity Mission to allow USGS to implement new requirements to the ground stations, $4,000,000 for coastal and marine spatial planning, and $4,000,000 to increase the scientific information that will be available to FWS, BLM, and NPS to inform resource management.

Decreases total $30,345,000. Decreases proposed include all unrequested Congressional increases in the 2010 Enacted Appropriations, which total $11,124,000; reduced funding for the National Map Partnerships, $3,500,000; general cost cutting proposals, $3,267,000; reducing funding for Information Technology (IT) efficiency gains, $4,000,000; reducing travel funding, $2,331,000; reducing IT funding $2,479,000; reducing acquisition funding, $3,571,000, and $73,000 for DOI Working Capital Fund redistribution. Fixed costs totaling $13,528,000 are being absorbed by programs throughout USGS.

Budget Change Summary *(Dollars in Thousands)*	
2010 Enacted	**$ 1,111,740**
DOI-wide Changes	-11,721
Program Decreases	-18,624
Program Increases	51,964
2011 Request	**$ 1,133,359**

Secretarial Initiatives

New Energy Frontier, $3.0 million – This request will expand work on the impacts of wind development on ecosystems. Performance will be improved by studying the causes and identifying solutions that will minimize risk and the ecological impacts of projected large-scale development of wind-farms and by improving data management, collaboration, and the viability of information products that contribute to the understanding of the effects of wind energy. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

Climate Change Adaptation, $11.0 million – USGS will support the accelerated assessment of biological carbon sequestration; create and staff two new DOI Climate Science Centers (CSCs) as part of the National Climate Change and Wildlife Science Centers, adding to the three CSCs established in 2010; and develop decision-support tools that enable resource managers and policymakers to cope with and adapt to a changing climate. Performance will be improved by testing and implementation of the biological carbon sequestration assessment methodology; establishment of additional science centers; and continuation of the collaboration with a number of universities and establishment of new partnerships. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

WaterSMART Program, $9.0 million – USGS will begin to implement the requirements of the Omnibus Public Lands Management Act of 2009 to determine the quantity, quality, and use of the Nation's water supply. Performance will be improved by the establishment of a robust effort to assess the availability of freshwater in the U.S. The USGS will develop critical information to characterize water flows, storage, use, water quality, and ecological needs. This focused effort will place tools and technical information into the hands of water resource managers and other stakeholders that will allow them to evaluate water availability to address serious questions they face each and every day. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

Youth in Natural Resources, $0.0 million – Secretary Salazar has challenged Departmental programs to increase youth employment. To achieve this, USGS will seek ways to expand opportunities for youth engagement through ongoing activities and partnerships. USGS will engage youth through meaningful work experiences, training, and graduate research in the natural sciences. These programs help USGS meet its scientific mission today, while also preparing the workforce of tomorrow. Improving retention of USGS youth will continue to be a top priority and one strategy to achieve this goal will be by raising the visibility and participation in USGS mentoring programs.

Treasured Landscapes, $3.6 million – This effort supports President Obama's Executive Order (E.O.) of May 12, 2009, to have the Federal government lead the restoration of the Chesapeake Bay, the Nation's largest estuary. The E.O. directs the U.S. Environmental Protection Agency, and the Departments of the Interior, Commerce (NOAA), Agriculture, Defense, and Homeland Security to use their expertise and resources, working with partners, to protect and restore the Chesapeake Bay and its watershed. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

Mission Initiatives

Increasing Resilience to Natural Hazards, $4.0 million – Will increase the Nation's resiliency to natural hazards by extending work in California communities and expanding efforts in the Pacific Northwest, and Alaska coastal communities. Performance will be improved through efforts which include; improved forecasting capabilities, better decision support tools and training for emergency responders, new studies to address urban and wildland fires, vulnerability assessments for volcanoes and improved monitoring capabilities for earthquakes and volcanoes. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

Landsat Data Continuity Mission (LDCM), $13.4 million – Will allow the USGS to implement the new requirements to the ground stations for the December 2012 launch. Performance will be improved by continuing the capability of providing data from the LDCM to users. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

Coastal and Marine Spatial Planning, $4.0 million – Will support the implementation of the Administration's National Ocean Policy. The USGS will actively engage with other DOI bureaus and Federal agencies in implementing the soon-to-be finalized "Framework for Effective Coastal and Marine Spatial Planning (CMSP). This Framework for CMSP includes implementation guidance for phased and collaborative development, including Federal, State, tribal, and other partners; to develop capacity, build on existing efforts, and leverage and gain efficiencies from lessons learned. More information about this increase can be found in the Secretarial Initiatives and Mission Increases, Section E.

FWS/NPS/BLM Science Support, $4.0 million – Will increase the number of USGS scientists that can work collaboratively with managers and biologists in FWS, BLM and NPS to develop and carry out research projects that address bureau management problems. Funding for FWS will be augmented by $1,500,000, and will include science support for adaptive management, and strategic and tactical research to meet the priority information needs identified by the FWS. A total of $1,500,000 will be added to programs that support NPS. Projects would include research on climate change adaptation and ecosystem change in parks, and other biological research, monitoring, and technical assistance of high priority to NPS. Support for BLM will be increased by $1,000,000 and will include nonforest fire research and ecoregional assessments of western systems. More information about this increase can be found in Program Increases, Section F.

Technical Adjustments

The 2011 budget includes three technical adjustments:

- the establishment of a Construction subactivity with funds transferred from Deferred Maintenance;
- a realignment of the Regional Executives' staffs (51 FTE) from the science disciplines to Science Support; and
- a realignment of 5 Geography FTE to Science Support related to contract and administrative support provided to the Earth Resources and Observation Center.

See section G for details.

Absorption of 2011 Fixed Costs Increases

To provide the maximum funding possible for priority program needs, the 2011 President's Budget Request does not include an increase for anticipated increases in fixed costs in 2011. Programs will absorb these costs. Estimates for 2011 fixed costs increases are footnoted in the table in each program section. Pay and benefits related costs will be absorbed by the programs proportional to the numbers of FTE employed. Rent cost increases will be absorbed by the programs occupying rental space. The Department's Working Capital Fund costs will be redistributed from 2010 resulting in a reduction of $73,000.

Management Efficiencies

Introduction

In 2009, the President established the SAVE Award program to challenge Federal employees across the government to submit their ideas for efficiencies and savings as part of the annual budget process. The goal of the SAVE Award is to produce ideas that will yield savings and improve government operations. Interior received thousands of submissions on a variety of topics during the SAVE Award process which are being reviewed by the Bureaus. The 2011 budget assumes $62.0 million in savings from implementing SAVE Award proposals in three areas: travel, information technology, and strategic sources, which are described below.

Travel Reduction – The USGS is participating in a Interior-wide effort to reduce travel and relocation expenditures through adoption of new technologies and efficiency improvements accounting. Bureaus are implementing new teleconferencing, videoconferencing, shared Web sites, and other technologies that will enable real-time communications and shared access to documents that will enable more meetings to be conducted remotely and electronically. The proposed reduction also includes a decrease in funding for permanent change of station expenses, in response to an Office of Inspector General finding that suggests a need for greater control over management of these costs. The overall travel reduction would decrease Interior's spending on travel and relocation to a level commensurate with actual 2008 travel and relocation expenditures. The USGS's share of this reduction is $2.3 million.

IT Reduction – The USGS Chief Information Officer has been working collaboratively with the other Interior CIOs on an approach to achieve improved effectiveness and efficiencies in information technology. Interior anticipates savings from the Interior-wide implementation of a common e-mail system and the consolidation of servers, data centers, and help desks. Although this is a multi-year effort, it is feasible to expect $20 million in savings in 2011, of which, USGS's share is $2.5 million. Secretary Salazar is committed to information technology reforms that will improve the effectiveness and efficiency of operations within Interior including a common email system. Detailed planning information exists from earlier efforts to deploy a common email system that provide a foundation for an accelerated effort, beginning in the current fiscal year. Interior has conducted inventories and evaluations of servers, data centers, and help desks. All of the information indicates significant potential savings from the consolidation and reduction of this infrastructure. Interior will be working throughout 2010 to develop plans, begin deployments, and implement changes so as to realize savings beginning in 2011.

Acquisition Reduction – The USGS Administrative Policy and Services Office of Acquisition and Grants has been working collaboratively with other acquisition offices across Interior to prepare an Acquisition Improvement Plan. Although the Office of Management and Budget's

(OMB) proposed acquisition savings program allows agencies to redirect savings to other mission objectives, Interior is proposing a reduction of $30 million in real savings to help offset other program priorities in the budget request, of which, USGS's share is $3.6 million. One option for achieving this savings is the expanded use of strategic sourcing.

Currently, strategic sourcing is used for enterprise acquisitions for software and hardware. Expansion of strategic sourcing to other types of acquisitions has the potential to achieve additional savings for the bureaus and offices in Interior. The Office of Acquisition and Property Management, working with a team of bureau representatives, has developed a set of options for strategic sourcing, including: telecommunications, relocations, copiers/printers, heavy equipment, recycled paper, shuttle services, furniture, wireless communications, and training. Currently, participation by the bureaus is optional.

Interior has a track record with successful strategic sourcing and plans to expand its use based on the advice and guidance from the Strategic Sourcing Executive Council. During 2010, Interior would develop its plans and begin to implement expanded strategic sourcing to realize the targeted savings in 2011. To achieve this level of savings, all of the bureaus would be required to participate. The leadership in Interior is committed to participation in this initiative. The savings realized from this initiative would be included in Interior's Acquisition Improvement Plan.

Cost Savings

The 2011 Budget request includes $3.3 million in cost savings as requested in OMB Memorandum 09-20, *Planning for the President's Fiscal Year 2011 Budget and Performance Plans,* dated June 11, 2009. Included are proposals for savings in rent, energy efficiencies at facilities, savings from work force planning, administration support consolidations in the field, elimination of competitive sourcing studies, savings in journal subscriptions, savings achieved by using Webex and other teleconference technologies to hold meetings along with a reduction in travel and meeting sponsorship. While savings are expected, there is no significant performance change associated with these cost saving reductions.

The USGS Library, managed by the Enterprise Information Resources subactivity, has converted funds previously used to purchase multiple print copies of over 1,000 scientific journals into bureauwide access online. This effort has expanded access to these journals beyond locations with a physical library, and the online usage has increased. In 2008, USGS staff downloaded on average 1,250 full-text articles from these journals daily. The average cost per article was $3.75; by comparison, subscription access to these journals ranges from $22.00 - $30.00 per article. The USGS Library is continuing this effort in 2010, consolidating print subscriptions into bureauwide access. For every 35 journals, the USGS is expected to save over $25,000 in 2011 and expand access of titles to staff all across USGS.

Department Crosscuts

For most Department crosscutting activities, USGS funding levels for science are preserved or increased in this budget. These crosscutting activities range from environmental issues such as the Everglades restoration and coral reef protection in the Pacific Islands to environmental and climactic change issues being studied under the Global Change activity. The following examples are some of the crosscutting activities to which USGS contributes: Great Lakes Restoration, Coral Reef Protection, Greater Everglades Ecosystem Restoration, Chesapeake Bay Restoration, Global Change, Columbia River Basin, Klamath River Basin, San Francisco

Bay Science, Coastal Ecosystem Studies (Pacific Coast), and Arctic Ecosystems. For more on the associated crosscuts, see Section H, Science on the Landscape.

Strategic Plan

In accordance with the Government Performance and Results Act of 1993 and with Office of Management and Budget policy and direction, Interior Strategic Plan is currently undergoing the required triennial review and update. Interior is reviewing the organization and construct of the Strategic Plan in light of the Administration's priorities, goals, and objectives. Although the majority of end outcome goals and measures, intermediate measures, and other measures are expected to remain intact, the organizing principles for those goals and measures may change during this review. Therefore, this budget request does not directly reference the existing Interior Strategic Plan mission areas, but does continue to report on performance goals and accomplishments associated with the current slate of end outcome goals and related performance measures. For more information on USGS's role in the Interior Strategic Plan revision, please go to section C.

High Priority Performance Goals (HPPG)

In 2009, the Office of Management and Budget (OMB) proposed an initiative that strove to identify federal agency's HPPGs as a way to develop "the President's agenda for building a high-performing government." As a result, the Department of the Interior chose five goals for the Department's bureaus to report on for the next two fiscal years. In 2010 through 2012, the USGS will be involved in three separate HPPGs: Renewable Energy, Climate Change, and Youth Stewardship for Resources.

The Department is developing a set of internal measures and milestones to monitor and track achievement of the HPPGs. Progress in these areas will be reported and reviewed throughout the year by the Deputy Secretary's Principals' Operation Group to identify and address any need for enhanced coordination or policy measures to address barriers to the achievement of the HPPG.

Renewable Energy Development

The USGS is a primary contributor to the Renewable Energy Development HPPG: *Increase approved capacity for production of renewable (solar, wind and geothermal) energy resources on Department of the Interior lands, while ensuring full environmental review, by at least 9,000 megawatts by 2012*. A key to achieving the renewable Energy HPPG is ensuring that there is an understanding of the national resource potential for renewable energies and the impacts of increasing their development.

Bureau Contribution: Energy and Minerals for America's Future is one of six science directions highlighted in the USGS Science Strategy. Consistent with the Renewable Energy Development HPPG, the 2011 budget includes the New Energy Frontier initiative that will build upon the core capabilities of the USGS as a multidisciplinary earth science agency. The USGS will investigate an array of renewable energy sources, including geothermal, biofuels, and wind and solar energy that contribute to this HPPG. In 2010, the USGS focused $3.6 million on renewable energy and in 2011, the USGS requests $6.6 million, a $3 million increase for wind energy.

Implementation Strategy: In conjunction with partners such as the Department of Energy (DOE), the USGS will focus work on providing a better understanding of the national geothermal potential. By the end of 2012, the USGS will provide a revised and updated geothermal resource classification.

Wind and solar provide potentially new energy sources, but will also have impacts as their development increases. Understanding these environmental impacts early on can help inform regulatory and development investments to be as effective as possible. On the land, the USGS work will focus on predictions of the impacts of mortality and habitat loss to avian and terrestrial wildlife populations, changes to surface and ground water supplies that will be associated with the likely solar and wind infrastructure build-out scenarios .

Regarding offshore wind development, the USGS will develop the mapping framework for offshore wind-energy development in conjunction with the Minerals Management Service (MMS), State agencies and other Federal mapping, charting, and regulatory agencies that would be used to inform the evaluation and regulation of offshore wind-energy development. By the end of 2012, the USGS will:

- Initiate work in the Great Plains and offshore Cape Cod region,that will lead toward developing an assessment methodology that can be applied nationwide.

As the use of biofuels continues to grow the understanding of broader impacts is just being understood. USGS efforts will focus on determining life-cycle effects of biofuels production in relation to greenhouse gas production and energy inputs, develop and validate models that simulate the effects of increased biofuel production on ecosystem services, land use changes, soil properties; and water quality and availability. By the end of 2012, the USGS will:

- Publish grassland and corn, irrigated and dryland, carbon flux maps to assess net ecosystem exchange of carbon in this basin under various biofuel production scenarios.
- Develop models that can be used to predict land use change scenarios and their affects on ecosystem services.

Climate Change

The USGS is a primary contributor to the Climate Change HPPG: *By 2012, the Department will identify areas and species ranges in the United States that are most vulnerable to climate change and begin implementing comprehensive climate change adaptation strategies in these areas.*

Bureau Contribution: climate change is one of six science directions highlighted in the USGS Science Strategy, and the USGS is a primary contributor to this HPPG through the following programmatic areas:

- science and data integration necessary to characterize the impact of climate change on lands and wildlife,
- science based tools for adaptive management, and
- assess carbon sequestration resources throughout the United States.

The USGS contribution to the Climate Change Science Program (CCSP) in 2010 is $68 million and $81.4 million in 2011.

Implementation Strategy: One of the challenges to developing strategies to adapt to climate change is having the right information at the right time to inform decisions. The USGS will build on its strong research and monitoring capabilities and work with other Interior bureaus to identify data and knowledge gaps and integrate key information necessary to characterize the impacts of climate change. By the end of 2012,

- build observation capability in the Arctic and sub-Arctic ecosystems,
- conduct research to improve the understanding of the vulnerability to coastal lands and communities to sea level rise, and
- complete a national assessment of changes in land cover and land use to use for forecasting of future trends.

The USGS assumes bureau participation and contributions to establish a coordinated infrastructure of Landscape Conservation Cooperatives (LCCs), supported by Interior Climate Science Centers, and an integrated climate monitoring approach. Establishment of the inter-bureau centers will help ensure that science and land management activities are closely integrated. Much of USGS contribution in this area will be led by the National Climate Change and Wildlife Center. By the end of 2012,

- the USGS will provide ecological and population modeling capacity to the Interior LCCs and provide information and training to the U.S. Fish and Wildlife Service (FWS) to characterize species-habitat interactions in site-specific projections at landscape, local or species scales for Strategic Habitat Conservation.
- the National Climate Change and Wildlife Center will move from concept to implementation where it will establish the fourth and fifth regional Climate Science Centers to help support high-priority research and modeling, share expertise, and begin collaborations with Interior and other resource managers to test and validate climate adaption strategies.

Carbon sequestration is potentially an important option for addressing the Nation's climate change challenges. Currently, there is no solid understanding of the national potential for sequestration, both geological and biological. To address this gap, USGS is working on national assessments for biological and geological sequestration. By the end of 2012, the USGS will:

- begin a three-year national assessment of geologic carbon sequestration capacity in depleted oil and gas fields and saline formations,
- continue research to better understand the uncertainties associate with geologic carbon sequestration to improve the methodology of the assessment, and
- conduct and complete the methodology development of the Lower Mississippi Deltas scheduled for June 2010.

Youth Programs

The USGS is also a contributor to the Youth in Natural Resources HPPG: *By 2012, increase by 50% (from 2009 levels) the employment of youth between the ages of 15-25 in the conservation mission of the Department.*

Secretary Salazar has challenged Departmental programs to achieve the HPPG for youth employment, a year ahead of schedule, by the end of 2010. The USGS is working towards the goal of increasing the number of youth employed by 35 percent in either through a permanent, term, or temporary position with the bureau, or a work experience in conjunction with a

partnering organization. To achieve this goal, the bureau will seek ways to expand opportunities for youth engagement through ongoing activities and partnerships as well as the additional funds appropriated directly.

USGS Contribution: USGS contributes to the Department's goal by engaging youth through meaningful work experiences, training, and graduate research in the natural sciences. These programs help USGS meet its scientific mission today, while also preparing the workforce of tomorrow.

Implementation Strategy: The USGS has a goal of a 35 percent increase of youth employees in 2010 by taking the following actions:

- Expanding the number of youth employed at USGS, by utilizing the full array of available hiring authorities, and
- Developing hiring pathways for young people, such as continuing to reform the hiring process, expanding our workforce planning efforts, creating targeted communications and outreach, and establishing career fairs in targeted locations.

In 2011, we foresee a continuation and expansion of these efforts in order to increase our number of employed youth commensurate with our funding availability. Improving retention of our youth will continue to be a top priority and one strategy to achieve this goal will be by raising the visibility and participation in our mentoring programs.

American Recovery and Reinvestment Act (ARRA)

The USGS received $140.0 million in funding through the American Recovery and Reinvestment Act (ARRA) of 2009. The ARRA funding provided unprecedented support for improving owned facilities; addressing remediation of abandoned groundwater wells, streamgages, and cableways; upgrades to monitoring capabilities for earthquakes and volcanoes; streamgage modernization and collection of much-needed elevation data, especially in coastal areas.

USGS used the ARRA funding to address eight programs within five budget areas:

Deferred Maintenance-Facilties (Facilities)
Construction (Facilities)
Deferred Maintenance – Streamgages, Cableways, and Wells (Facilities)
Upgrades to Streamgages (National Streamflow Information System)
Earthquake Monitoring (Earthquake Hazards)
Volcano Monitoring (Volcano Hazards)
Imagery and Elevation Data for Mapping (National Geospatial Program)
Data Preservation (Facilities)

Through ARRA funding, the USGS will meet the 2013 deadline of the requirement to upgrade radio transmission on streamgages to be able to use a new NOAA satellite. Approximately one-fourth of the stations in the Advanced National Seismic System (ANSS) will be upgraded to meet goals set for implementation of ANSS. The National Volcano Early Warning System will begin a robust upgrade to digital systems and implementation of newly developed instruments. Critical elevation data along the United States coasts will be gathered and archived and data preservation will be advanced by digitizing historic records. The USGS will address a large

proportion of its inventory of facilities repair in order to provide functional and technical workspace needed to advance its program missions.

In addition to addressing key mission needs, these projects will create or retain jobs, engage youth during project implementation, reduce energy consumption in Federal facilities, and utilize renewable energy in comprehensive monitoring systems. Furthermore, ARRA projects that collect or generate new data sets will make this information available through *recovery.gov*, as well as the Administration's new government-wide data portal, *data.gov*.

The following list describes the projects status at the end of 2009:

Deferred Maintenance – Facilities **$30,375,000**

Approximately 67 projects have been identified for deferred maintenance. Below is a list of significant examples:

- Upgrade the electrical system at the USGS Great Lakes Science Center in Ann Arbor, Michigan, and reduce annual energy usage and costs.
- Upgrade the USGS Great Lakes Science Center's Tunison Laboratory of Aquatic Science in Cortland, New York, to improve safety and reduce energy usage and costs.
- Replace the Lake Superior research vessel (R/V) Kiyi's anchor system. The R/V Kiyi is operated from the USGS Great Lakes Science Center's Lake Superior Biological Station in Ashland, WI.
- Build two new large research vessels for the USGS Great Lakes Science Center's fleet, replacing 50-year old vessels used for critical inventory and monitoring of Great Lakes lake trout and the health of other important fish stock overseen by management agencies on Lakes Erie and Ontario.

Construction **$18,325,000**

- The Patuxent Wildlife Refuge Research Center in Patuxent, MD; the Columbia Environmental Research Center (CERC) in Columbia, MO; and the Upper Midwest Environmental Services Center (UMESC) in LaCrosse will undertake significant design and construction.

Deferred Maintenance – Streamgages **$15,000,000**

- Remediation and to make abandoned streamgages, wells and cableways that still exist in all 50 states safe for use by USGS staff.

Streamgage Upgrades **$15,000,000**

- The USGS national streamgage network (7,500 sites) is dependent on a NOAA operated satellite for real-time data transmission. NOAA is requiring all those that use the satellite to convert to new high-data rate radio (HDR) technology by 2013. The USGS will use Recovery Act funding to upgrade to HDR technology and upgrade streamgages with new technologies for streamflow measurement in advance of the planned 2013 conversion.

Seismic Monitoring **$30,200,000**

- Upgrade earthquake monitoring networks, including the Advanced National Seismic System and the Global Seismographic Network (jointly funded by the National Science Foundation).

Volcano Monitoring **$15,600,000**

- Upgrade Volcano Monitoring Networks in Alaska, Hawaii, the Pacific Northwest, Yellowstone National Park, California and the Marianas Islands, consistent with the plan contained in the National Volcano Early Warning System.

National Map **$15,000,000**

- Update and enhance out-of-date mapping information with imagery and elevation data.

Data Preservation **$500,000**

- Digitize Bird Banding Laboratory records still extant only in paper form vulnerable to aging.

Science Strategy

The USGS Science Strategy, *"Facing Tomorrow's Challenges—U.S. Geological Survey Science in the Decade 2007–2017,*" is helping us to better target our science toward some of the Nation's most pressing natural-science issues. The six strategic science directions USGS will focus on, with an integrated perspective include:

• Understanding ecosystems and predicting ecosystem change;
• Climate variability and change;
• Energy and minerals for America's future;
• National hazards risk and resilience assessment program;
• Environment and wildlife in human health; and
• Water census in the United States.

Section B contains information on the current activities and areas of focus of the USGS Science Strategy.

Partnerships that Foster Innovation and Leverage Resources

Our ongoing efforts to develop partnerships that promote scientific advancement and innovation in support of our mission are critical. The USGS values collaborative relationships and seeks opportunities to build mutually productive partnerships that keep science relevant, foster innovation and allow for leveraging funds. A variety of partnership vehicles employed by USGS programs are described at *http://www.usgs.gov/aboutusgs/working_with_us/partnerships.asp*

Examples of the depth and breadth of partnerships are documented throughout the budget document. The following is a representative listing of USGS cross-cutting relationships with Federal, State, local, and non-governmental, and international organizations.

Federal
National/Governmentwide: National Geospatial Program Office, *The National Map***,** National Spatial Data Infrastructure, National Biological Information Infrastructure, National Earthquake Hazards Reduction Program, U.S. Global Change Research Program, National Atlas, Geographic Names, Imagery, Elevation and Hydrography Data Collection Programs, Civil Applications Committee
Agriculture(USDA)/USFS: Endangered Species, Conservation genetics, Habitat management, Forest planning, Wildlife, Invasive species, Fire science, National Forest maps, Drought/Fire fuel monitoring and management, Energy and mineral resources, Natural hazards, Mine lands, Land cover characteristics, Hydrologic data collection/studies, topographic maps, digital orthophoto and elevation data, *The National Map,* National Hydrography Dataset, and geographic names
Commerce/NOAA: Endangered Species, Salmonid restoration, Coral reefs, Hazards monitoring and research, Geomagnetism, Vegetation change, Coastal erosion, Fish habitat, Marine sanctuaries, Geographic Information System, Commerce/ National Institute of Standards and Technology: Earthquake Hazards, coastal and bathymetric mapping
DOD: Geospatial Coordination with States, Endangered Species, Salmonid restoration, Coral reefs, Coastal erosion, mapping support during conflict, Natural hazards, Test ban monitoring, Strategic minerals and energy resources, Geomagnetism, Terrain visualization, Hydrologic data collection/studies. Environmental contamination and remediation studies on military bases, NORTHCOMM, High-resolution imagery over urban areas
DOD/Army Corp of Engineers: Endangered Species, Habitat assessment, Fish behavior, Fish physiology, Dam impacts, Wetlands restoration, Seafloor mapping, Shoreline stability, Floodplain morphology, Mine lands, Energy resources, Natural Hazards, Hydrologic data collection/studies
Energy: Endangered Species, Bio-resource monitoring, Contaminant cause and effects, Gas Hydrates, Mining technology, Energy resources, Geologic hazards, Groundwater framework, Coalbed methane, Hydrologic data collection/studies, Geologic Sequestration
EPA: Endangered Species, Endocrine disruption, Contaminant effects, Status/Trends, Mine lands and drainage, Emissions modeling/clean air, Water quality, Seafloor mapping, Geochemical analyses, Coal resources and mining, Urban dynamics/land characterization, Hydrologic data collection/studies Remote sensing, Mineral baselines, GAP Analysis, National Hydrography Dataset
Federal Energy Regulatory Commission Permittees/Licensees: Hydrologic data collection/studies, Restoration of Threatened and Endangered migratory fish
Homeland Security/Federal Emergency Management Agency: Hazards monitoring and mitigation, Hydrologic data collection/studies, Floodplain mapping, providing emergency maps, elevation data
Health and Human Services: Chemical Analyses
Intelligence Community: Information coordination, Environmental/ resource studies, Hazards Support, Geospatial data coordination
Interior/BLM: Rangeland Health, Wild Horse Management, Invasive Species, Abandoned Mine Lands, Air Quality, Threatened and Endangered species, Water Quality, Mineral Resource Assessments, Prescribed Fire, mapping of National Petroleum Reserve/Alaska (NPR/A), mapping and geospatial data and analysis, National Hydrography Dataset
Interior/BOR: Water quality, Ecological models, Decision Support Systems, Seismic Monitoring.
Interior/FWS: Inventory and Monitoring, Aquatics and Contaminants, Biological resources, Threatened and Endangered species, Water Quantity/Quality, Gap Analysis Program, Geospatial data
Interior/Minerals Management Service: Gas hydrates
Interior/NPS: Water quantity/quality, Geologic mapping, Biological resources, Volcano hazard assessment, mapping and geospatial data, National Hydrography Dataset
Interior/Office of Surface Mining: Acid mine drainage
Justice: Geospatial Information System
Labor: Energy resources
National Academy of Science: Hazards studies, Geographic research, Evaluating licensing of geospatial data, K-12 geography curricula
NASA: Planetary research, Landsats 5 and 7 operations, design of Landsat Data Continuity Mission. Natural hazards, Earth Science research, Data management, Land Processes Distributed Active Archive Center, GIS, United Nations Environment Program clearinghouse, Remote sensing, Spaceflight support; Shuttle Radar Topography Mission
National Institutes of Health: Human health and environment, West Nile virus mapping with CDC
Interior: FWS, NPS; USDA: Animal and Plant Health Inspection Service, the Centers for Disease Control and Prevention: Highly Pathogenic Avian Influenza
National Science Foundation: Hazards studies, Antarctic research and mapping, Global seismology
Smithsonian Institution: North American vertebrate collections, Volcanic hazards

State: Natural hazards, Energy resources, Global seismology, Hydrologic data collection/studies, Famine Early Warning System, Pan American Institute of Geography and History, Geospatial Support.
Tennessee Valley Authority: Hydrologic data collection/studies
Transportation/Federal Highway Administration: Hazards studies, Hydrologic data collection/studies
Transportation/Federal Aviation Administration: Volcanic hazards
U.S. Agency for International Development: Geologic hazards, Hydrologic data collection/studies, Energy resources, Atmospheric moisture index
State and Local Government
Airports: Volcanic hazards
American Indians/Alaska Natives: K-12 educational resources, Streamgaging, Water quality/ quantity, Technical training and capability upgrade, Environmental hazards, Fisheries research, Invasive species, NativeView for American Indian colleges and universities, and Geospatial Support
Civil Defense: Hazards mitigation
Departments of Natural Resources/Geographic Information Councils: Volcanic hazards, Map data integration, Hydrologic data collection/studies , Orthoimagery
Departments of Environmental Protection/Quality/Health: Hydrologic data collection/studies, Mapping data
Departments of Fish and Game/Conservation Commission/Wildlife and Parks: Endangered species, Population dynamics, Habitat requirements, Fire management, Fisheries, Wildlife disease, Invasive species, Waterfowl surveys, Bird banding, Aquaculture, GAP Analysis, Geospatial Support
Offices of Emergency Management: Hazards monitoring and mitigation, Providing emergency maps
Planning Commissions/Transportation/Engineering/Municipalities: Conservation plans, Hydrologic data collection/studies, Topographic mapping, Hazards monitoring/assessment, Creating decision support systems for local decisionmaking
State Geological Surveys: Geologic and topographic mapping, Hazards assessment
Higher Education: University participation in AmericaView
Water Resources Authorities/Public Works/Sanitation: Contaminant Transport, Hydrologic data collection/studies
Non-government Organizations
American Farm Bureau/American Society of Civil Engineers/Chemical Manufacturers Association/etc.: Coordination of hydrologic programs
American Red Cross: Hazards monitoring and mitigation
Electric Power Research Institute: Coal quality
Industry: Spatial data modeling, Spatial data browsing and retrieval, Product development, registration, and production, Environmental monitoring, Acid rain deposition program, Hazard monitoring, research and assessments
The Nature Conservancy: Endangered species, Species at Risk, Ecological research, Biological Status/Trends, Coordination of hydrologic programs, GAP Analysis, Decision Support System
National Geographic: Geospatial information coordination
Universities/Cooperative Fish and Wildlife Research Units/State Water Resources Research Institutes: Planetary research, Space-based instrumentation, Natural science information delivery, Natural science research and applications, Hazards research and monitoring networks, Training/education, Geologic mapping, Hydrologic data collection/studies, GAP Analysis
Southern California Earthquake Center (University consortium): Earthquake hazard research and assessment
Utilities: Seismic studies, Hydrologic data collection/studies
NatureServe: NBII, Geospatial Support, Decision Support System
Association of Fish and Wildlife Agencies: chronic wasting disease
Ducks Unlimited: database development and data access for Latin American And Caribbean waterfowl surveys
Other Partners: Breeding bird survey, Bird banding, Water resources education/outreach, topographic maps, topographic mapping
International
Global: The USGS has conducted earth science studies and provided natural hazards support in foreign countries for over 50 years. Authorization is provided under the Organic Act, as revised, and the Foreign Assistance Act and related legislation when such studies are deemed by the Interior and Department of State to be in the interest of the American people.

Research and Development (R&D)

Supporting Economic Growth and Innovation

Investments in Research and Development (R&D) are key to promoting economic growth and innovation and ensuring American Competitiveness in a global market. R&D is the core of USGS mission. The USGS 2011 R&D funding associated with the budget request is $679 million or 59.9 percent of the USGS budget, a net increase of $18.6 million from the 2010 Enacted Budget. This increase is due to additional funding requested in research for key initiatives such as New Energy Frontier, Climate Change Adaptation, and WaterSMART Program.

The 2011 OMB and Office of Science and Technology Policy (OSTP) R&D priorities memo outlined four practical challenges for R&D that research should address. Below are the four challenges and examples of how USGS investments address the challenges:

- **Applying science and technology strategies to drive economic recovery, job creation and economic growth.** USGS provides baseline information and syntheses on land, biological, water, energy and mineral resources that inform decisions regarding key resource inputs to our national economy. In addition, USGS deploys monitoring equipment across the country, providing a wide array of opportunities for innovation to test new remote sensing, water sampling and geographic information systems technologies.

- **Promoting innovative energy technologies to reduce dependence on energy imports and mitigate the impact of climate-change while creating green jobs and new businesses.** The 2011 request includes additional funding to study the impacts of renewable energy development, advance the understanding of impacts of climate change so that decisions can be made to mitigate impacts on wildlife, and allow for USGS to reduce its carbon footprint.

- **Applying biomedical science and information technology to help Americans live longer, healthier lives while reducing health care costs**. USGS brings an interdisciplinary approach to addressing environmental aspects of human health and provides monitoring and research on specific topics such as animal disease transmission to humans, drinking water contaminants and air-dust-soil-sediment rock contaminants.

- **Ensuring we have the technologies needed to protect our troops, citizens and national interests, including those needed to verify arms control and nonproliferation agreements essential to our security**. USGS Natural Hazards programs are critical to public safety. The Bureau has initiated a multi-hazard approach to natural hazards that integrates research, monitoring, and reporting efforts on earthquake, volcano, tsunami, landslide and flood related hazards. In addition, USGS along with the National Science Foundation, funds the Global Seismographic Network which supports non-proliferation goals of the Comprehensive Test Ban Treaty Organization.

Ensuring the quality of USGS Science programs. As part of the annual budget formulation the bureau reviews R&D investments across its disciplines and weighs the value of existing programs against changing needs and priorities. The Director prioritizes proposed initiatives on the basis of:

- interdisciplinary science; collaboration and partnerships with Department bureaus, other government agencies, and universities (relevance);
- results of program evaluations; and demonstration of progress toward meeting the Department's performance goals and objectives.

The Director selects the prioritized initiatives that can be accommodated within the funding target.

The USGS has always taken the integrity, objectivity and utility of our science seriously by:

- conducting peer review of USGS research and evaluations of USGS programs through the Fundamental Science Practices process to ensure quality, and
- surveys of customer satisfaction with USGS science products and services and listening sessions with stakeholders and customers to obtain feedback on product usefulness and use to ensure relevance.

Fundamental Science Practices. The USGS regularly conducts internal control reviews on its programs and organizations in accordance with the OMB Circular A–123, Management's Responsibility for Internal Controls. In 2008 the USGS began using the internal control review process to validate adherence to fundamental science practices to ensure **quality** of science and to stand behind the Director's Assurance Statement regarding the USGS programs delivering mission.

Peer review is a Fundamental Science Practice at the USGS, substantiating the quality investment criterion, and servicing as a performance measure for all programs. In 2008, the USGS began using the A-123 Internal Control Review process to validate the peer review process. In 2009, the USGS implemented the peer review process for four programs:

- Land Remote Sensing
- Geologic Resource Assessments
- Water Resources Research Act Program
- Cooperative Research Units

Peer review addresses:
- Scientific Excellence, Integrity and Objectivity
- Conflict of Interest
- Impartiality and Nonadvocacy
- Methodology and Documentation
- Public Benefit and Access
- Natural Hazards and Public or Wildlife Health
- Accessibility and Corporate Identity

Roles and responsibilities of those in the review and approval process were tested and were generally found to be working as intended. In addition to validating the process, the control testing identified areas that could be further improved, and these recommendations were provided to the Fundamental Science Practice Advisory Council for consideration.

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"*Facing Tomorrow's Challenges*--- U.S. Geological Survey Science in the Decade 2007 - 2017"

Background

The U.S. Geological Survey (USGS) science strategy (Strategy) is outlined in Circular 1309, *Facing Tomorrow's Challenges – U.S. Geological Survey Science in the Decade 2007 – 2017*. Published in 2007, the document was created to identify science goals and priorities that unite bureau capabilities toward challenges for the future. The Strategy outlines areas where natural science can make substantial contributions to the Nation and the world. It identifies opportunities for USGS to better use its scientific capabilities to serve the Department of the Interior (Interior) and the Nation. In doing so, it is intended to inform long-term approaches to USGS program planning, technology investment, partnership development, and workforce and human capital strategies.

The Strategy does not cover *all* facets of USGS work. It builds upon a hierarchy of planning documents. It provides a science-based response to the overarching Interior strategic plan and is a follow-up to previous looks at USGS strategic planning efforts.

The choice of strategic science directions was guided by the view that complexities of measuring, mapping, understanding, modeling, and predicting the status and trends of natural and managed resources in the United States transcend the traditional USGS structure and require broad interdisciplinary thinking and action. The Strategy defines priority areas and opportunities where the USGS can serve the Nation's pressing needs. The Strategy provides a framework to unite and integrate USGS capabilities and takes advantage of its strengths and unique position as a non-regulatory Federal science agency with national scope and responsibilities.

Implementing these strategic directions will strengthen USGS' role as a premier science agency that strengthens the Nation with the information needed to meet the challenges of the 21st century.

In the Strategy's focus areas, "Where We Are" shows key increases in funding over several years and "2011 Request" highlights current funding requests which build on past investments. These efforts are referenced as anecdotal examples only and do not represent totality of funding for any given effort.

Understanding Ecosystems and Predicting Ecosystem Change: Ensuring the Nation's Economic and Environmental Future

Societal Concerns

Large-scale, rapid change is taking place in all natural systems throughout the world. Growing human populations and substantial alterations to landscapes, oceans, and the atmosphere have caused widespread changes in the global distribution and abundance of organisms. Changes in biodiversity alter ecosystem processes, productivity, and structure, and often reduce resilience of ecosystems to future environmental change. Permafrost melting, landscape fragmentation, mining scars, forest clearing, and coral reef bleaching are just some of the many examples of ecosystem change. People value ecosystems in their own right, and as they decline or collapse, environmental foundations upon which human society has been built may begin to erode. Effective management of ecosystems and natural resources depends on a thorough knowledge of types and distributions of ecosystems and their attributes, in concert with a comprehensive understanding of ecosystem processes.

What's Needed

USGS reports on the state of the Nation's terrestrial, freshwater, and coastal/marine ecosystems and studies the causes and consequences of ecological change, monitors and provides methods for protecting and managing biological and physical components and processes of ecosystems, and objectively interprets for policymakers how current and future rates of change will affect natural resources and society. USGS works in collaboration with Federal, State, and local partners and non-governmental organizations to understand the distribution, interactions, condition, and conservation requirements of organisms in an ecosystem context, and predicts changes to biodiversity resulting from land-cover change, climate change, and other impacts to ecosystems. USGS and its partners will advance understanding of ecosystem structure, function, patterns and processes through collaborative research. Based on the outcomes of this research USGS and its collaborators will develop new products, including standardized national maps of ecosystems in the United States, and will provide updated reports on the status of ecosystems and assessment of trends that will help land managers and decisionmakers make informed decisions that take into account ecosystem health and sustainability.

Drivers

USGS Ecosystem Council
Interior Adaptive Management Handbook
Executive Order 13508 - Chesapeake Bay Protection and Restoration

What's Been Done

Hundreds of ecosystems exist throughout the United States each with its own unique set of plant and animal life, hydrologic, geologic and chemical composition and range. Through a geospatial mapping project USGS has completed a three year effort to model the potential distribution of terrestrial ecosystems for the conterminous United States. This resulted in mapping 419 different types of terrestrial ecosystems as defined by an ecosystems classification developed by NatureServe, a non-profit organization whose international network of biological inventories and data management tools are used by a wide variety of government agencies, corporations and academia. This is the first step in determining the world-wide distribution of ecosystems commissioned by the Group on

Earth Observations (GEO). The GEO-designated member nation leading the global ecosystem mapping task is the United States government which has delegated USGS as the lead Federal agency for this work.

Determining the distribution of ecosystems is only the first step in understanding our ecosystem environments. Across the country USGS scientists are collaborating with local, state and Federal partners to collect data which can be analyzed and modeled to further the understanding of these complex ecosystems. From the Florida Everglades and Biscayne National Parks to Washington's Nisqually Delta and Alaska's Beaufort Sea, a comprehensive set of models and data is being developed and collected so that we can better characterize and provide science-based information to land managers and decision makers at all levels of government.

Where We Are

American Recovery and Reinvestment Act of 2009	
Great Lakes Vessels	+$7.0
Upgrading Streamgages	+$14.6
Data Preservation	+$0.5
2009 Appropriations:	
Great Lakes Biological Science	+$1.0
Biologic Carbon Sequestration	+$1.5
2010 Appropriations:	
Chesapeake Bay	+$4.8
Enhance the National Streamgage Network	+$5.0
National Water Availability and Use Assessment Initiative	+$1.9
Changing Arctic Ecosystems	+$4.2
Support for U.S. Fish and Wildlife Service (FWS) Climate Change Activities	+$5.0
Biologic Carbon Sequestration	+$5.0
New Energy Frontier (wind, solar, geothermal, biofuels)	+$3.5

2011 Initiatives and Increases

Several key initiatives are related to the Ecosystems science direction that utilize the breadth of USGS science capabilities and move them forward to meet the challenges we face in the 21st century. Treasured Landscapes initiative will focus on mapping and modeling the Chesapeake Bay which is the largest estuary in the United States with a watershed that spans 64,000 square miles and touches six states. The WaterSMART Program also contains some key areas which relate to the water requirements of the environment and its wildlife. Of major concern is the impact that natural hazards such as earthquakes and volcanoes have on the environment and the ecosystems that are prevalent in areas which could be impacted by these events such as Alaska and the Pacific Northwest. Coastal and marine spatial planning will address issues affecting the coastal and marine ecosystems. From coast to coast, these initiatives will have a symbiotic effect with their data supporting a new and deeper understanding of the ecosystems of our Nation.

Treasured Landscapes – The Chesapeake Bay is a prime example of a complex ecosystem whose processes need to be understood before making decisions on how to manage these natural resources based on the observed changes taking place due to both natural and human induced stresses. The habitat and food web services provided in the Chesapeake Bay and other ecosystems are dynamic and sustain both resident and migratory species as well as a great diversity of aquatic and terrestrial plant life.

On May 12, 2009 President Obama issued an Executive Order (E.O.) to have the Federal government lead the restoration of the Chesapeake Bay. The E.O. directs shared Federal leadership among the U.S. Environmental Protection Agency (EPA) and the Departments of the Interior,

Commerce (Commerce), Agriculture, Defense, and Homeland Security to use their expertise and resources, working with partners, to protect and restore the Chesapeake Bay and its watershed. USGS has been conducting research on the Chesapeake Bay for many years and this is not new territory for USGS. Additional support allows the FWS, National Park Service (NPS) and USGS as well as the National Oceanic and Atmospheric Administration (NOAA) and the Chesapeake Bay Partners (CBP) to improve information to prepare mitigation and adaptive strategies to manage and conserve priority living resources, habitats, and Interior lands.

2011 Proposed Activities

- Enhance models to better predict the impact of sea-level rise and storm surge on coastal areas and Interior lands;
- Begin to construct ecosystem models of priority fish and wildlife species (that are identified by FWS and CBP partners) in the Bay watershed;
- Plan an integrated monitoring program to document changing ecosystem conditions for priority species and their habitats; and
- Develop a joint Interior Landscape Conservation Cooperative to use models and other information in an adaptive-management approach to improve decision-making to address impacts of climate and land change on priority species and Interior parks and lands.

WaterSMART Program – Water is essential to the economic security of individual communities across the United States. Capturing the needs for both human and environmental health and putting those needs into context with the need to strengthen the health of the Nation through agriculture, energy and industry are important water use topics which need to be addressed. The health of ecosystems is affected by changes in land use and cover, natural and engineered infrastructure, water use and climactic changes. Data and information on all of these factors will be collected and models will be developed which will forecast likely outcomes so USGS partners, Interior bureaus and other Federal agencies can make informed land use decisions.

2011 Proposed Activities

- Increase knowledge of the current status and trends of water flows, storage, quality, and the use of water. Similar to the development of economic and population statistics provided by agencies such as the U.S. Census Bureau, this initiative will account for the changing amount, quality, and use of water resources across the Nation; and
- Conduct systematic analyses within the areas of geographic focus to determine the quantity of water, with sufficient quality and flow characteristics required to meet both human and ecological needs.

Increasing Resilience to Natural Hazards
Natural hazard events such as earthquakes, volcanic eruptions, wildfires and mud slides have a direct impact on not only the quality of life of humans, but on the surrounding ecosystems which we inhabit. As a part of this initiative USGS proposes to expand research in “disaster consequences”. This will strengthen impact-focused research and integrate it with hazards science to provide community leaders with a more complete picture of the consequences of disasters. The primary areas of research will be environmental impacts and the affect on human health, the impacts on ecosystems and endangered species and economic consequences of both. The Multi-Hazards Demonstration Project (MHDP) has been ongoing in Southern California for four years. USGS has prototyped methodology to integrate science across differing expertise to create an overarching product

which will address each of these important topic areas related to ecosystems.

2011 Proposed Activities

- New effort to study fires triggered by earthquakes in both urban and wildland environments;
- Institute formal environmental disaster response, research, and planning capability to support emergency responders; and
- Develop multi-hazard risk and vulnerability assessments at high threat volcanoes.

Coastal and Marine Spatial Planning – Interior, with substantial coastal and ocean resource management responsibilities, has a critical role in implementation of the Administration's National Ocean Policy. The USGS will actively engage with other Interior bureaus and Federal agencies in implementation of the soon-to-be finalized "Framework for Effective Coastal and Marine Spatial Planning". Work would enhance data and provide tools to evaluate the vulnerability of coastal and shallow marine communities and ecosystems.

2011 Proposed Activities

- Support real-time storm surge mapping; and
- Develop tools for coastal zone managers to forecast likely impacts of sea-level rise and future storms on managed resources.

2011 Request

	Requested Increase
Treasured Landscapes	+$3.6
WaterSMART	+$ 9.0
Increasing Resilience to Natural Hazards	+$4.0
Coastal and Marine Spatial Planning	+$4.0

Climate Variability and Change: Clarifying the Record and Assessing Consequences

Societal Concerns

Consequences of climate change and increasing carbon dioxide are of public concern. Direct effects of warming, including heat-related deaths are compounded by myriad indirect effects of climate change on various societal infrastructures, such as power blackouts and increasingly variable water supplies in many parts of the country. The media is increasingly reporting on scientific discoveries of the effects of climate change, such as increased disease outbreaks and ocean acidification. When interactions among components of a system are not directly proportional, the system is considered nonlinear. Scientific insight into the direct and indirect, including nonlinear, effects of climate change on local and regional resources must be the catalyst for changes in planning and management of land, water, and other natural resources in the United States and elsewhere. If we can understand the linkages, we can better manage and adapt to change.

What's Needed

USGS scientists will meet the needs of Interior, policymakers, and resource managers for scientifically valid state-of-the-science information and predictive understanding of climate change and its effects. Studies of interactions among climate, earth surface processes, and ecosystems across space and time will contribute to goals of U.S. Climate Change Science program. USGS will expand research and monitoring initiatives in the science of carbon, nitrogen, and water cycles, hydroclimatic and ecosystem effects of climate change, and land-cover and land-use change. USGS will continue studies of paleoclimate and past interactions of climate with landscapes and ecosystems, and apply knowledge gained to understanding future states and processes. Expanded and modernized USGS networks of land, water, and biological resources are crucial to rigorous analyses of future responses to climate change. USGS will provide tools to test adaptive strategies, reduce risk, and increase potential for hydrologic and ecological systems to be self-sustaining, resilient, or adaptable to climate change.

Drivers

U.S. Climate Change Science Program
Copenhagen 15
Secretarial Order 3285 “Addressing the Impacts of Climate Change on America’s Water, Land and Other Natural and Cultural Resources”
Energy Independence and Security Act of 2007 (EISA, P.L. 110-140)

What's Been Done

The world we live in is complex. The full effects that humans have on the environment we inhabit are unknown. What can be said is that the climate is changing and we have to develop new methods for measuring that change and providing models and data to policymakers around the world to use in the decision making process. The USGS is using a variety of methods to quantify this change. Remote sensing research is being used in the Shenandoah National Park and across the Great Plains to conduct analyses of the implications of contemporary land transformation. These “living laboratories” are being used to detect evidence of climate change by monitoring the changes in the forest canopy, vegetation, hydrology, and habitats in these areas. “Phenocams” are being added to these sites to capture digital images of the changes that are occurring in the landscape over time.

The USGS is also evaluating the physical changes occurring in Alaskan glaciers. The collection of this annual data continues to be accomplished through the USGS Benchmark Glacier Program which began in 1957. These long term data sets are used widely by climate change researchers throughout the world and have proven invaluable in developing and calibrating models which forecast the effects of climate change on water resources, sea-level rise, and fresh water input to near-shore marine ecosystems.

Biologic and geologic carbon sequestration studies are being conducted and show great promise in these areas of research. Controlled experiments on marsh elevation have shown that higher carbon dioxide levels actually stimulate higher root and rhizome growth belowground which increases the soil volume and marsh surface elevation. These factors can be built into models for climate change and sea-level rise and provide new insights into how our planet is reacting and adapting to its changing environment

As more research is conducted and new data sets are collected, better and more robust models can be developed. These products will help formulate new and better understandings of our changing world and assist in making the decisions on how to slow the rate of that change or adapt to it.

Where We Are

American Recovery and Reinvestment Act of 2009	
Imagery	+$14.6
Streamgage Upgrades	+$14.6
2009 Appropriations:	
National Climate Change and Wildlife Science Center	+$10.0
Geologic and Biologic Carbon Sequestration	+$3.0
Climate Change Science	+$5.0
Extended Continental Shelf	+$3.0
2010 Appropriations:	
Climate Change Science	+$5.0
Carbon Sequestration	+$7.0
Support for FWS Climate Change Activities	+$5.0
DOI Climate Science Centers	+$5.0
Changing Arctic Ecosystems	+$4.2

2011 Initiatives and Increases

Climate Change Adaptation – There are three main focuses in the climate initiative at USGS: assessment of the biological carbon sequestration resources within the United States; DOI Climate Science Centers (CSC) which are being established across the Nation as part of the National Climate Change and Wildlife Science Center (NCCWSC); and science application and decision support tools to meet the needs of resource managers. Each of the elements of this initiative is interrelating and employs a focus on developing the next generation of scientists to confront these and other Department of the Interior science mission needs.

Biological carbon sequestration refers to both natural and deliberate processes by which carbon dioxide is removed from the atmosphere and stored in vegetation, soils, and sediments The Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) calls for comprehensive assessment of geologic and biologic carbon sequestration to enable decision makers to evaluate the full range of sequestration options. In 2009 and 2010 USGS developed methodologies for a National Assessment of Biological Carbon Sequestration. In 2011, work will focus on: implementing these methodologies; utilizing mechanisms for consultations with Interior resource managers, stakeholders from other Federal agencies, private sector, and the science advisory panel created in 2009; and addressing technical issues and data gaps identified in 2010.

The Consolidated Appropriations Act of 2008 (P.L. 110-161) directed the USGS to begin the development of the NCCWSC which focused on providing climate change impact data and analysis geared to the needs to fish and wildlife managers as they develop adaptation strategies in response to climate change. DOI Climate Science Centers (CSC), part of the NCCWSC, are being developed in close collaboration with Interior bureaus as well as with other Federal, State, university and non-governmental partners. Coordinating these efforts on a national scale in collaboration with partners allows for uniformity of downscaling and forecasting models and standardized information to support management decisions.

2011 Proposed Activities
Biological Carbon Sequestration Assessment

- Testing and implementing of the biosequestration assessment methodology developed in 2009 and 2010;
- Conducting workshops (regional and national) to engage stakeholders; and
- Prototyping the methodology in the Mississippi River Delta region which exhibits a high diversity of both land cover and land uses.

DOI Climate Science Centers

- Use and create high resolution climate modeling information and derivative products to forecast ecological and population response at national, regional, and local levels;
- Integrate physical climate models with ecological, habitat, and population response models;
- Forecast fish and wildlife population and habitat changes in response to climate change;
- Develop standardized approaches to modeling and monitoring techniques;
- Partner with and coordinate science capabilities across the region, including Federal, university, state, Tribal, local government, and nongovernmental organization partners to provide climate change impact research, monitoring, forecasting, and decision support tool development;
- Synthesize and integrate existing climate change impact data gathered by the Department and external partners, identify current gaps in knowledge, and develop management-relevant products that communicate climate change impacts;

Science Application and Decision Support

- Continue the development of decision-support tools that enable resource managers and policymakers to cope with and adapt to a changing climate;
- Develop new partnerships, enhance existing collaborations and train the next generation of applications scientists; and
- Continue development and expansion of collaborative efforts among the bureaus to encourage the interdisciplinary utilization of the DOI CSC science.

Treasured Landscapes Initiative – In addition to supporting the Ecosystem Science Strategy the Treasured Landscapes initiative also has a focus on climate change. Changing temperatures on our planet can affect estuary ecosystems (sea-level rise, storm surge, and changing land cover in the watershed areas) and have dramatic consequences for the flora and fauna which reside or migrate through these areas. Building models to determine what further changes may take place is an important step in developing adaptive-management approaches to compensate for the effects of climate change.

2011 Proposed Activities

- Enhance models to better predict the impact of sea-level rise on Interior parks and FWS refuges;
- Plan an integrated monitoring program to document changing ecosystem conditions for priority species and their habitats; and
- Develop joint Interior models and other information in an adaptive-management approach to improve decision-making to address the impacts of climate and land change on priority species.

Coastal and Marine Spatial Planning – Research and hydrologic/marine modeling are needed by managers to address the impacts on critical coastal resources of changes in water resource availability in response to climate change and changes in industrial and consumptive use. Information provided will support State-identified and Federal priorities relevant to coastal and marine managers for climate adaptation.

2011 Proposed Activities

- Mapping, assessment, and modeling of coastal change and vulnerability including national assessments of coastal erosion, storm and sea-level rise vulnerability;
- Regional erosion and coastal landscape change studies; and
- Establish monitoring and assessment protocols and standards and provide data to address the most prevalent human impacts on coastal ecosystems.

2011 Request

	Requested Increase
Climate Change Adaptation	
Carbon Sequestration Assessment	+$2.0
DOI Climate Science Centers	+$8.0
Science Applications & Decision Support	+$1.0
Treasured Landscapes Initiative	+$3.6
Coastal and Marine Spatial Planning	+4.0

Energy and Minerals for America's Future: Providing a Scientific Foundation for Resource Security, Environmental Health, Economic Vitality, and Land Management

Societal Concerns

Two issues dominate future energy/mineral availability: globalization and likelihood that environmental changes from energy and mineral extraction and consumption will factor more strongly into society's use of them. Developing countries lead global competition. Demand for resources is expected to grow. In the latter half of the 20th Century, the issue of environmental effects saw increased awareness of contamination (oil spills, dam failure, acid rain, clear-cut forests, and increased carbon dioxide). Globalization and environmental impacts point to a future of a diversified energy mix, changing demands for minerals (to support innovative technologies), and lifecycle approach linking energy/mineral use to broad effects of use (e.g., exploration, extraction, recycling, disposal). Emphasis needs to be placed on consequences of land and water use, ecosystem health, and human welfare. USGS research factors in public discourse about future of energy and minerals, and it informs and engages decision makers.

What's Needed

USGS energy and minerals resource research will focus on decisions about future natural resource security, environmental effects of resource use, economic vitality, and management of natural resources on Interior, Federal and other lands. A wide-ranging, multidisciplinary approach is used to understand and evaluate how the complex life cycle of occurrence, formation processes, extraction methods, use, and waste products of energy and mineral resources influence, or are influenced by, landscape, hydrology, climate, ecosystems, and human health. Cumulative knowledge, long-term data, and new understanding of resource origin and assessment methodologies will improve reliability and accuracy of assessments and information, especially as the energy mix evolves and new requirements for rare and scarce materials emerge. Information will be put in economic terms so that policymakers can more clearly weigh competing alternatives. Through partnerships and collaborations, USGS natural resource knowledge and expertise helps advance the economy and improve competitiveness.

Drivers

National Materials and Minerals Policy, Research and Development Act of 1980
The Energy Policy Act of 2005
The Energy Independence and Security Act of 2007
Secretarial Order 3285 "Addressing the Impacts of Climate Change on America's Water, Land and Other Natural and Cultural Resources"

What's Been Done

The USGS has a long standing program dedicated to mapping the mineral and energy resources of the United States and the world. The preliminary model for porphyry copper deposits which was originally published in 1986 has been updated to include greater variety of deposit attributes. The resource assessments of the Cook Inlet Region of Alaska have been updated with a new digital compilation of that area which can be combined with a wide variety of other geologic, geochemical, geophysical and historical data to generate derivative maps. The USGS has also produced a geologic map of a 7,000 square mile region in southwestern Alaska which shows numerous potential reserves of gold,

copper, lead and zinc. This mapping is also being done for the World Petroleum Project which has published an updated assessment in 2008 which included a Circum-Arctic Resource Appraisal. The USGS is now concentrating on those reserves in South America, Asia and Africa.

In addition to providing maps and models of the Earth's geologic formation and resources, the USGS is also determining what ecological impacts development of these resources could have. In the Powder River Basin in Wyoming and Montana, coalbed natural gas is being explored as a new source of minable energy. Local landowners, downstream irrigators, gas industry representatives and regulators are all concerned about what impacts this development may have on the groundwater in the area. The USGS is providing those models by operating stream gages and water quality monitors in the area to assess the potential impact. These studies are only the beginning as new technologies (geothermal, wind, solar and biofuels) are developed; more research will have to be conducted to explore the impact that these may have to our society and environment.

Where We Are

2010 Appropriations:	
New Energy Frontier (wind, solar, geothermal, biofuels)	+$3.0

2011 Initiatives and Increases

New Energy Frontier (Wind) – The need for new domestic sources of energy to create a Nation less dependent on foreign sources as well as sources which are more environmentally friendly have driven increasing interest in alternative technologies such as geothermal, solar, biofuels, and wind. USGS will use additional funds to conduct further research, modeling, and monitoring to assess the ecological impacts to fish and wildlife associated with the large-scale development of wind energy. The results of this analysis will be shared with resource managers so that science-based decisions can be made on the potential development of wind-farms in the Great Plains and offshore in the Atlantic.

2011 Proposed Activities

- Identify causes and potential solutions to minimize risk to fish and wildlife and assess ecological impacts of projected development of wind-farms in the Great Plains and offshore waters of the Atlantic in the Cape Cod region; and
- Develop an assessment methodology that can be applied nationwide to the impacts to fish and wildlife from direct strikes, habitat fragmentation, and construction and maintenance of infrastructure.

2011 Request

	Requested Increase
New Energy Frontier	+$3.0

A National Hazards, Risk, and Resilience Assessment Program: Ensuring the Long-Term Health and Wealth of the Nation

Societal Concerns

Natural hazards threaten United States safety, security, economic well-being, and natural resources. Sudden extreme events (hurricanes, wildfires, flash floods, earthquakes), capture public attention. Equally threatening are effects of slower, chronic hazards related to climate change (drought and ecosystem collapse). Much of United States infrastructure is aging and vulnerable to hazards. Expanding urbanization of coastal zones, floodplains and wildland-urban interfaces heightens risk of future disasters. With disaster-relief costs mounting, the United States must have a clear understanding of potential threats, societal vulnerability to these threats, and strategies for resilience. Need for action is urgent. Until recently the number of lives lost to natural hazards in the United States each year has declined, but the cost of response to and recovery from disasters continues to rise. Working with partners, USGS builds understanding through assessment of hazards, societal risks, and vulnerabilities, providing managers/policymakers at all levels with tools to make better and more cost-effective decisions.

What's Needed

The USGS collects accurate and timely information from modern earth observation networks, assesses areas at risk from natural hazards, and conducts focused research to improve hazard predictions. In addition, USGS works actively with the Nation's communities to assess the vulnerability of cities and ecosystems and to ensure that science is effectively applied to reduce losses. The USGS will develop a national risk-monitoring program, built on a robust underpinning of hazard assessment and research, to visualize and provide perspectives at multiple scales of vulnerability and resilience to adverse land change and hazards. Accurate observations, focused research, and timely communications will safeguard people and property and keep the occurrence of natural hazards from becoming natural disasters.

Drivers

Increased earthquake occurrences around the world
National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act of 2004
Disaster Relief Act of 1974 (P.L. 92–288 Stafford Act

What's Been Done

Reducing property damage, loss of life, and impacts to the environment from natural hazards is one of the critical issues of the 21st century. To help officials and communities reduce these potential losses the USGS developed improved capacity to assess and communicate societal vulnerability to these hazards. The improved capabilities were demonstrated on January 12, 2010, USGS was able to rapidly assess and report on the size, location and likely impact of the 7.0 magnitude earthquake in Haiti.

The USGS has delivered and trained local and state officials on the use of tools such as NetQuakes, ShakeMap and tsunami hazards warning systems. Near real-time data makes these systems useful not only in the planning process for disaster response at the Federal, State and local levels but also in the actual response to events. In Pierce County, Washington the USGS participated in a "table top" exercise for a simulated Tacoma Fault earthquake in

which USGS scientists calculated the ground motions for a magnitude 7.1 earthquake. ShakeMaps and "Did You Feel It" maps were streamed via the Internet to simulate the event. The results of this will be used to develop a series of standardized ground motion models to be used as the basis for state and local planning across the nation, with many such exercises occurring in earthquake prone areas to prepare for these hazards.

Floods, volcanoes, sea-level rise, coastal change, wildfires, mud slides, and hurricanes all pose a risk to life, property and the environment. By creating tools and early warning detection the USGS can help inform and educate the public on these hazards as well as be a partner in formulating response mechanisms.

Where We Are

American Reinvestment and Recovery Act of 2009	
Deferred Maintenance – Streamgages	+$14.6
Streamgage Upgrades	+$14.6
Earthquake Monitoring	+$29.4
Volcano Monitoring	+$15.6
2009 Appropriations:	
Earthquake Program Increase	+$1.0
Volcano Program Increase	+$1.5
Global Seismographic Network	+$1.0
2010 Appropriations:	
Enhance the National Streamgage Network	+$5.0

2011 Initiatives and Increases

Increasing Resilience to Natural Hazards
Since 2007, the USGS has worked in close cooperation with stakeholders in Southern California in the MHDP which has enabled the USGS to evaluate what science is most useful, how it can be applied, and how to encourage its use in making policy decisions and emergency response strategies. In just over two years, major policy decisions have been made using the USGS ShakeOut scenario which simulated a major earthquake on the Southern San Andreas Fault. The activities piloted in this project now form a cornerstone for a national program to assess hazards, risks and resiliency in communities where these events occur. In 2011 this initiative will: (1) expand the MHDP by developing an earthquake forecasting and early warning capability and conducting impact analysis of environmental, human health and ecosystem responses to earthquakes and other hazards; (2) improve forecasting for volcanic and seismic events in the Pacific Northwest by installing additional seismic and continuous GPS instruments at high threat volcanoes; (3) install structural instrumentation on public infrastructure which is necessary to produce more accurate records of the locations, magnitudes, peak recorded ground shaking due to earthquakes which will lead to more accurate ShakeMaps; (4) provide training in the use of these products so that local, state, and Federal emergency responders can accurately utilize the tools developed in emergency response planning; (5) implement the MDHP approach to Alaska's coastal communities to assess and monitor earthquake, tsunami, and volcanic activity and train emergency responders and public planners in the use of these tools; and (6) add volcanic earthquake detection capacity to the USGS National Earthquake Information Center which currently provides 24/7 detection and rapid location, analysis and dissemination of information for earthquakes world-wide.

2011 Proposed Activities

- Forecast earthquake risks in California on timescales from hours to centuries;
- Provide decision-support tools to better prepare for the likelihood of a large San Andreas earthquake;
- Provide formal environmental disaster response, research, and

planning capability to support emergency responders;
- Begin a new effort to study fires triggered by earthquakes in both urban and wildland environments;
- Develop multi-hazard risk and vulnerability assessments at high and very high-threat volcanoes;
- Create products used for planning and training for disaster response by the Department of the Interior as part of their Disaster Response Plan for Alaska;
- Construct a catalog of onshore and offshore earthquake sources along the southern and southeastern Alaska margin, and improve our understanding of specific earthquake hazards along that margin;
- Add a volcanic earthquake detection component to National Earthquake Information Center (NEIC) by providing the necessary data transmission improvements to import real-time seismic data from the five USGS volcano observatories;
- Deploy 30 NetQuakes stations in Washington and Oregon; and
- Install additional sensors on the Makushin Volcano in Alaska.

2011 Request

	Requested Increase
Increasing Resilience to Natural Hazards	+$4.0

Environment and Wildlife in Human Health: A System that Identifies Environmental Risk to Public Health in America

Societal Concerns

Environmental health threats to the Nation's citizens are an inescapable consequence of the interactions between people and their physical, chemical, and biological environment. As towns and cities expand, the wildland-urban interface broadens and human wildlife interactions become more frequent. Many public health issues affecting Americans, such as avian influenza, originate outside our borders, requiring the Nation to maintain global vigilance for potential health threats. The emergence of many new human diseases in recent years is directly related to worldwide increases in population density, mobility, and environmental disruption.

Current health problems caused by zoonotic diseases (transmissible between animals and humans, such as West Nile virus and avian influenza) and environmental contamination (for example, mercury in fish, arsenic in water) are not isolated examples. Future generations will continue to be affected by many of the diseases that have emerged or resurged during the past quarter century, regardless of whether the causes are chemical, microbial, or parasitic. Dealing with emerging and resurging diseases requires the ability to anticipate potential environmental and ecosystem health threats, recognize pathogens or contaminants when they first appear, and respond quickly and appropriately. Because many zoonotic disease outbreaks are evident in wild animal populations before they affect people, wildlife health and disease monitoring serves as an indicator of environmental and ecosystem health and is thus essential to any information system for protecting human health.

What's Needed

The USGS provides scientific and monitoring information essential for helping to identify existing, emerging, and resurging environmental and ecosystem health threats. This strategic goal will be achieved by integrating existing USGS human-health related data, by establishing an interactive information system for environmental threats, and by enhancing collaborative research with allied public health organizations. These steps will enable USGS to provide the scientific information needed for a better understanding of the connections among all living things and the environments in which we live. The USGS proposes to develop an online data atlas of potential environmental health threats that consolidates USGS data and provides data for researchers and public-health agencies to enhance the ability to respond quickly to current threats and anticipate potential future health threats. The USGS will create new partnerships, and strengthen existing ones.

Increased levels of collaboration at all levels are needed to address the Nation's environmental health-related issues. Enhanced rapid and long-term response teams to evaluate short- and long-term health implications of disasters are critical. USGS will develop and implement a national-scale, environmental health information system that combines biological, water-quality, and geologic information with Geographic Information System (GIS) decision-support tools. USGS plans to publish a report every half decade that includes the status and trends in environmental, animal, and earth science information. The report will describe the way conditions are changing, present new findings relating to public health, and

explain the methodological and research contributions that USGS has made and transferred to managers.

Drivers
Zoonotic disease outbreaks
Population fluxes

What's Been Done
Wildlife, natural and human contaminants, and diseases related to both are causes of great concern to human and ecosystem health. From the fate and transport of toxins in drinking water to the increased contact and exposure humans have to wildlife the human health connection needs to be understood. White nose syndrome in bats, although not detrimental to humans can cause downstream effects in the population of mosquitoes which carry a number of human pathogens. Dust transport from arid regions of the globe and release of endocrine disrupting chemicals into the environment all cause human health impacts.

The USGS is studying these linkages by creating rapid response assays for wildlife diseases and recording continuous water quality data to aid researches in modeling the spread and transport of these chemicals. Identification and response to these human health threats is necessary and can only be done by providing the critical data and tools necessary to decision makers. The USGS is doing this and will continue to do so well into the 21st century.

Where We Are

2009 Appropriations:	
National Climate Change & Wildlife Center	+$10.0
2010 Appropriations:	
DOI Climate Science Center	+$5.0

2011 Initiatives and Increases

Climate Change Adaptation – DOI Climate Science Centers (CSC) will be expanded to a total of 5 regions across the Nation as part of the National Climate Change and Wildlife Science Center (NCCWSC). The science conducted will include the relationship of climate change in wildlife and plant disease susceptibility and spread.

WaterSMART Program – The need for clean water is vital to not only the health and well being of this Nation's citizens but also its environment and wildlife. As a component of the Water Conservation initiative the USGS will collect and analyze water quality data in addition to quantity, tracking changing flow characteristics, use and storage of water, and will develop models and predictive tools to guide water resource use and policy decisions.

2011 Proposed Activities

- Knowledge of the current status and trends of water flows, storage, quality, and the use of water. Similar to the development of economic and population statistics provided by agencies such as the U.S. Census Bureau, this initiative will account for the changing amount, quality, and use of water resources across the Nation;
- Systematic analyses within the areas of geographic focus will determine the quantity of water, with sufficient quality and flow characteristics, which are required to meet both human and ecological needs; and
- Improved characterization of the Nation's aquifers, including geologic description, changes in yields, and identification of zones of high-quality and poor-quality water.

2011 Request

	Requested Increase
Climate Change Adaptation	
DOI Climate Science Centers	+$8.0
WaterSMART Program	+$9.0

A Water Census of the United States: Quantifying, Forecasting, and Securing Freshwater for the Future

Societal Concerns

Water is essential for healthy communities, economies, and natural environments. The United States needs information that summarizes a full range of requirements related to freshwater quantity and quality for human, economic, and environmental health. The USGS proposes to undertake a Water Census to account for the trends in freshwater quantity and quality for human and environmental needs. The Census will provide updates on status of quantity of freshwater available; quality of freshwater needed; how quantity and quality of available freshwater changes over time; and whether sources of water that are currently considered to be freshwater can be made available for human and environmental needs. Information on how much freshwater is available, and whether supply of it is increasing or decreasing over time, is essential for economic and environmental health. Improvements are needed in determining amounts of water used for mining, livestock, power generation, supply, environmental needs. Nontraditional sources, such as saline, offshore freshwater aquifers, will be evaluated.

What's Needed

The USGS will develop a Water Census of the United States to inform the public and decision makers about the status of its freshwater resources and how they are changing; the Census will provide for a more precise determination of water use for meeting future human, environmental, and wildlife needs by providing an understanding on how freshwater availability is related to natural storage and movement of water, as well as engineered systems, water use, and related transfers. Identifying water sources not commonly thought to be resources will be studied, hopefully providing new freshwater sources for human and environmental needs. Forecasts of likely outcomes for water availability, water quality, and aquatic ecosystem health caused by changes in land use and land cover, natural and engineered infrastructure, water use, and climate will become a reality based on temporal monitoring.

Drivers

Circular #1331, A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States
Secure Water provision of P.L. 111-11

What's Been Done

USGS is collecting and analyzing a vast amount of data in order to assess the quantity, quality and use of our Nation's water resources, though more work is still needed. Through surface and groundwater gauging network and water quality monitors, the USGS has aggregated and made available a vast amount of data on our waters resources. From assessing the Yakima, Denver, Hondo & Green River Basins' groundwater resources to developing the geologic framework of mid-Continent carbonate and High Plains aquifers, the USGS is well on its way to mapping a country-wide understanding of the Nation's water resources.

Where We Are

American Reinvestment and Recovery Act of 2009	
Streamgage Equipment Upgrade	+$14.6
Streamgage Deferred Maintenance	+$14.6
2009 Appropriations:	

National Streamflow Information Program Increase	+$2.0
2010 Appropriations:	
Enhance the National Streamgage Network	+$5.0

2011 Initiatives and Increases

WaterSMART Program – Water is essential to the economic security of individual communities across the United States. Understanding the water needs for both human and environmental health, as well as for agriculture, energy and industry, is vital to the vitality of our Nation as a whole. The United States needs a new assessment of water availability that provides a foundation for developing models and predictive tools to guide water resources decisions. The President signed into law the Omnibus Public Land Management Act of 2009 (P.L. 111-11) on March 30, 2009. This Act directed the Secretary of the Interior to establish a National Water Availability and Use Assessment Program. To meet the requirements of the Secure Water section of the P.L. 111-11 the USGS proposes to create the USGS WaterSMART Availability and Use Assessment to understand the location and distribution of water and also the requirements of human use including agriculture, municipalities, industry and electric power generation. By creating seamless national information on water availability which spans political and jurisdictional boundaries, the USGS proposes to place technical information and tools into the hands of stakeholders that will allow them to evaluate water availability as a factor in decisions they are required to make related to land use and planning.

2011 Proposed Activities

- Increase knowledge of the current status and trends of water flows, storage, quality, and the use of water, similar to the development of economic and population statistics such as the U.S. Census Bureau;
- Complete systematic analyses within the areas of geographic focus to determine the quantity of water, with sufficient quality and flow characteristics, which are required to meet both human and ecological needs;
- Improve characterization of the Nation's stream and river flows, including storage in large lakes, reservoirs, snow, and ice fields;
- Improve characterization of the Nation's aquifers and identify zones of high-quality and poor-quality water;
- Improve knowledge of water use and how it is changing over time;
- Improve understanding of the needs of aquatic species for streamflow; and
- Provide access to better, more comprehensive water information to help the Bureau of Reclamation, U.S. Army Corps of Engineers, and State and local agencies to manage large watersheds and aquifers in the face of climate change, demographic change, and water use change.

2011 Request

	Requested Increase
WaterSMART Program	+$9.0

Data Integration and Beyond

Societal Concerns

By providing both the big picture and specific local information, USGS earth observation and geographic information meet an array of needs for knowledge about the landscape: from tracking changes in land use and human development to documenting the devastation caused by storms and wildfires. The USGS will use its information resources to create a more integrated and accessible environment for its vast resources of past and future data.

USGS will invest in cyberinfrastructure, nurture and cultivate programs in natural-science informatics, and participate in efforts to build a global integrated science and computing platform.

What's Needed

Natural events (volcanic eruptions, earthquakes, wildland fires, floods, droughts, variable and changing climate, environmental impacts from manmade toxins, invasive species, and animal-borne diseases) all affect humans and pose significant risks to society. In addition, using and competing for natural resources on the global scale has the potential to impact the Nation's ability to sustain its economy, national security, quality of life, and natural environment. Understanding health, natural resource, and hazard risks, better defining their probabilities, and forecasting their effect on the status and future of society are essential for a resilient and prosperous United States. The Nation needs ready access to natural science information to make informed decisions on how to address these risks. As the Nation's leading natural science and information agency, USGS is well-positioned to accept the challenge of providing this integrated information.

National decision makers and scientists within and outside the USGS require enhanced access to decades of observational data and analysis. The key to advancing new discoveries of the Earth's complex systems and processes, as well as making decisions regarding potential risks, lies in the rigorous analysis of system interconnections and feedbacks. Central to the identification and evaluation of these connections is the accessibility of data and information across multiple scientific disciplines, geographic, temporal, and political boundaries. Data integration within the USGS is a prerequisite for joining international efforts to develop worldwide science collaboration and a computing platform that can address future challenges. The USGS will use its information resources to create a more integrated and accessible environment for its vast resources of past and future data. It will invest in cyber-infrastructure, nurture and cultivate programs in Earth-system-science informatics, and participate in efforts to build a global integrated science and computing platform.

Drivers

Global economic and environmental issues

What's Been Done

Data is only useful if it is available in a format that is understandable and accessible. The USGS has made great strides in the comprehension and standardization of data. Declassified images from the Global Fiducials Library have been made available to the public through the web to support analysis of global climate-related science and environmental change. Enhanced web access to the USGS' National Land Cover Dataset (NLCD) was also accomplished by developing a web tool called the Land Cover Analysis Tool. This tool improves the

access to and usability of the land cover data by allowing users to develop web applications that "consume" the NLCD from a remote server so that calculations can be performed on the data and then display the results as a map image or in tabular form for more analysis.

Not only is USGS releasing its own data in more usable and accessible ways but also aggregating data from various sources for more robust and meaningful data analysis and modeling development. In the Piceance Basin in northwestern Colorado a data repository has been developed using data from over 50 cooperating entities including Federal, State, local and private industry which collected water quality data in that area. This data will be used to develop a baseline assessment of the region's water resources.

These are just a few examples of how USGS is aggregating and making data available to the public. In the future USGS will strive to make even more data and tools available to a larger segment of users.

Where We Are

American Reinvestment and Recovery Act of 2009	
Streamgage Equipment Upgrade	+$14.6
2009 Appropriations:	
National Streamflow Information Program Increase	+$2.0
2010 Appropriations:	
DOI Climate Science Centers	+$5.0
Enhance the National Streamgage Network	+$5.0

2011 Initiatives and Increases

WaterSMART Program – The Water Conservation initiative depends on the integration and leveraging of state data sets to complete a comprehensive map of the country's water resources. Most information about human water use is obtained through programs operated by State water resource agencies. Understanding that State water resource agencies are the cornerstone to the success of this effort the USGS will implement a grant program to State water agencies that are developing water use and availability datasets which can be integrate with national water use information to advance the understanding in this area. The data can only be used if it is presented and available in a format that can be easily used by resource managers. The goal of the USGS is to provide this information at scales defined by the end user in a simple "point and click" interface so that timely information can be accessed quickly and efficiently

2011 Proposed Activities

- Provide access to better, more comprehensive water information to help the Bureau of Reclamation, U.S. Army Corps of Engineers, and State and local agencies to manage large watersheds and aquifers in the face of changing climate, demographics, and water use.

Increasing Resilience to Natural Hazards
Making data related to natural hazards readily available and understandable is essential to helping prevent the loss of human life. Earthquakes, volcanoes, tsunamis, mud slides, wildfire, hurricanes and other natural disasters can have catastrophic effects on both human and environmental populations and habitat. Data which can help abate some of these consequences needs to be integrated into a single understandable and accessible platform for it to be useful. This initiative plans to do that as it has with the Multi-Hazards Demonstration Project in Southern California. By aggregating data from Federal, State, and University systems the platform is more accurate and has been readily accessible to decision makers, emergency responders and the public to help inform and guide policy decision and emergency response strategies.

2011 Proposed Activities

- Create decision-support tools to better prepare for the likelihood of a large San Andreas earthquake; and
- Add a volcanic earthquake detection component to NEIC by providing the necessary data transmission improvements to import real-time seismic data from the five USGS volcano observatories.

Climate Change Adaptation – The Science Application and Decision Support element of this initiative applies directly to data integration and making this data available in a scale and format that is readily usable by resource managers and policymakers. National coordination of research and modeling at the Interior Climate Science Centers will ensure uniformity of downscaling and forecasting models and standardized information to support sound science based management decisions and foster partnership collaborations.

2011 Proposed Activities

- In collaboration with the scientific community develop science information and tools that can inform management strategies for responding to climate change; and
- Deliver these relevant tools and information timely and directly to resource managers.

Coastal and Marine Spatial Planning – Responding to the direction provided by the Ocean and Coastal Mapping Integration Act, USGS will coordinate the planning, collection, and provision of geospatial data and products by continuing the efforts of the Interagency Working Group on Coastal and Ocean Mapping, and ensuring a coordinated development building on the infrastructure established within FGDC/GOS, the MMS Multipurpose Marine Cadastre, and regional and national implementation of Integrated Ocean and coastal Observing System (IOOS).

2011 Proposed Activities

- Develop standards and tools for data and model integration and visualization supporting IOOS development priorities;
- Enhanced coastal LIDAR mapping of high-resolution elevation integrated with imagery for resource characterization; and
- Enhance development of the geospatial framework.

2011 Request

	Requested Increase
WaterSMART Program	+$9.0
Increasing Resilience to Natural Hazards	+$4.0
Climate Change Adaptation	+$11.0
Coastal and Marine Spatial Planning	+$4.0

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Department of the Interior Strategic Plan Revision 2011 - 2016

Overview

In accordance with the Government Performance and Results Act of 1993 and in response to the Office of Management and Budget (OMB) policy and direction, the Department of the Interior (Interior) Strategic Plan is currently undergoing the required triennial review and update. The Department is reviewing the organization and construct of the Strategic Plan in light of the Administration's priorities, goals, and objectives. As a part of the strategic planning process, Interior has added science as a mission area. This addition is representative of Interior's recognition that a strong science program is necessary to inform many of the management decisions made by all Interior bureaus and Interior's broader role in finding solutions to societal challenges that reach beyond Interior lands, such as climate change, water availability and natural hazards. The U.S. Geological Survey (USGS) is engaging partners, customers, and staff at all levels to assess priorities and choose areas of focus. Since the Interior Strategic Plan is currently being revised, for comparative purposes, USGS is required to use the construct and strategic plan performance measures found in the Interior Strategic Plan 2007 – 2012 for Fiscal Year 2010.

In the Interior Strategic Plan 2007 – 2012, science lies at the foundation of Interior programs. USGS programmatic outcomes directly contribute to the goals of understanding

- National Ecosystems and Resources;
- Energy and Mineral Resources; and
- Natural Hazards

to inform decisions on land and resource management and planning, managing and mitigating the effects of natural hazards by Federal, State and local governments and private citizens. While these challenges will remain as a focus for the USGS and the Interior in the revised Interior Strategic Plan, the USGS will express the goals in a different manner that better reflects efforts aligned with the USGS Science Strategy.

USGS's Contribution to the Interior Strategic Plan Revision

As part of the USGS efforts to contribute to the development of a science mission, we have sought comments and suggestions from our partners, customers, and employees. USGS employees at all levels of the organization, particularly Regional Executives, Chief Scientists and Program Coordinators, are being engaged to help shape the Science mission area goals and their respective strategic plan performance measures. This collaboration is imperative because the Interior strategic plan represents the priorities of the agency and Secretary, and is reflected in USGS Senior Executive Service performance plans. The programs must report to the information in the plan. In addition, the USGS will work with other Interior bureaus and the Office of the Secretary to ensure that the Science mission area is reflective of all science programs Department-wide.

USGS input on development of the Science mission area will be strongly informed by the six science directions of the USGS Science Strategy. The six science directions represent cross-

cutting themes that represent the core of USGS work and are areas where the USGS can and does have a significant positive societal impact. These areas are:

- Understanding Ecosystems and Predicting Ecosystem Change: Ensuring the Nation's Economic and Environmental Future;
- Climate Variability and Change: Clarifying the Record and Assessing Consequences;
- Energy and Minerals for America's Future: Providing a Scientific Foundation for Resource Security, Environmental Health, Economic Vitality, and Land Management;
- A National Hazards, Risk, and Resilience Assessment Program: Ensuring the Long-Term Health and Wealth of the Nation;
- Environment and Wildlife in Human Health: A System that Identifies Environmental Risk to Public Health in America, and
- A Water Census of the United States: Quantifying, Forecasting, and Securing Freshwater for the Future.

The USGS Science Strategy identifies science goals and priorities that unite bureau capabilities to address current challenges and those in the future. Therefore, the Science mission area in the Interior Strategic Plan should also reflect many of these same goals and priorities of the USGS.

The revised Interior Strategic Plan under development, would include USGS programmatic outcomes that contribute to goals, such as

- Science for Sustainable Resource Use, Protection, and Adaptive Management;
- Science to Protect and Empower Communities; and
- Multi-Dimensional Science and Information Framework for Understanding the Earth.

While the revised DOI Strategic plan is still under development, our actions to date combined with the new directions of the USGS Science Strategy have informed the presentation of the 2011 Budget.

Performance Measures

A key to transitioning a strategic plan to improved outcomes is the development of meaningful performance measures. USGS is currently in the process of revising performance measures that appear in the Interior Strategic Plan 2007 – 2012, with the goal of better alignment of our performance measures with the USGS Science Strategy and the revised Interior Strategic Plan that will recognize Science as a mission area of the Interior. In addition, the USGS has taken initial steps and will continue to streamline the amount of reported performance measures, to ensure that performance measures are budget sensitive, not difficult to calculate, and underscore the selected measures' utility to the programs as a management tool.

Science for Sustainable Resource Use, Protection, and Adaptive Management

Identify and Predict Ecosystem Change to Protect and Sustain Environmental Resources

Identify and Model the Causes and Impacts of Changes to the Earth and Ocean System to Inform Management Strategies

Assess and Forecast Climate Change and its Effects to Develop Mitigation and Adaptation Strategies

Monitor and Assess Water Availability and Quality to Meet Water Resource Needs

Assess the National and Global Energy and Mineral Resource Endowment to Enhance Economic Vitality

Science to Protect and Empower Communities

Monitor Natural Hazards and Assess Risk and Resilience

Identify the Key Pathways and Risk Factors between the Environment/Wildlife and Human Health

Multi-Dimensional Science and Information Framework for Understanding the Earth

Advance the Information Framework to Discover, Integrate, and Preserve Data for Science and Natural Resources Stewardship

Create Geologic Maps and Models for Sustaining Resources and Protecting Communities

Advance the Application of Remote Sensing and Geospatial Information and Technologies for Understanding Changes to the Earth

Providing the Scientific Foundation For Decision-Making

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2011 President's Budget Request - BA in thousands
Crosswalk of DOI Goals to Budget Activities
(Dollars in Thousands)

Account/Budget Activity	DOI Goals			TOTAL
	Improve the Understanding of National Ecosystems and Resources Through Integrated Interdisciplinary Assessment	Improve the Understanding of Energy and Mineral Resources to Promote Responsible Use and Sustain the Nation's Dynamic Economy	Improve Understanding, Prediction, and Monitoring of Natural Hazards to Inform Decisions by Civil Authorities and the Public to Plan for, Manage, and Mitigate the Effects of Hazard Events on People and Property	
Surveys, Investigations, and Research				
Geog Res., Investigations & Remote Sensing	153,442			153,442
Geologic Hazards., Resources, and Processes	77,585	83,328	92,920	253,833
Water Resources Investigations	228,827			228,827
Biological Research	201,344			201,344
Enterprise Information	33,343	3,825	4,333	41,501
Global Change	72,099			72,099
Science Support	62,192	7,128	8,064	77,384
Facilities	84,327	9,665	10,937	104,929
SIR Appropriation, Total	913,159	103,946	116,254	1,133,359

2011 Goal Performance Table

Target Codes:	SP = Strategic Plan Key measures	ARRA = Recovery Act measure	
		UNK = Prior year data unavailable	
	TBD = Targets have not yet been developed	BUR = Bureau specific measure	
		NA = Long-term targets are inappropriate to determine at this time	
Type Codes:	C = Cumulative Measure	A = Annual Measure	F = Future Measure

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
% of targeted science products that are used by partners or customers for land or resource decision making **(SP)**	A	93%	93%	93%	≥90%	91%	≥90%	≥90%	0	≥90%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of partners that sought and used science products for species, habitat, and land management, and/or regulatory decision-making **(BRM)**	C	86.9%	90.4%	90.4%	67%	90.4%	68%	69%	+1%	70%
% of targeted fish and aquatic populations for which information is available regarding limiting factors, such as migratory barriers, habitat, and effects of disturbance (fire, flood, nutrient enrichment) **(SP) (BRM)**	A	31%	38.66% (46/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	0	43% (51/119)

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
% of North American migratory birds for which scientific information on their status and trend are available to inform and improve conservation **(SP) (BRM)**	A	26%	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	27.1% (176/650)	+0.5%	27.1% (176/650)
% of targeted invasive species for which scientific information and decision support models are available to improve early detection (including risk assessments) and invasive species management **(SP) (BRM)**	A	51.6%	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	0	54% (3.25/6)
% of data and information resources being accessed for science and science-based decision-making **(BIMD)**	C	UNK	13.11%	20.52%	21.00%	21.34%	21.5%	20.5%	-1%	21.00%
Total projected cost ($000)		**---**	**$5,750**	**$5,250**	**$5,250**	**$5,000**	**$5,750**	**$5,550**	**-$200**	**$5,750**
Actual cost per catalogued resource in NBII (whole dollars)		**---**	**$175**	**$102**	**$102**	**$94**	**$106**	**$111**	**+$5**	**$106**
% of focal migratory bird populations for which species pages are available through the NBII **(BIMD)**	C	UNK	8%	15%	22%	22%	29%	36%	+7%	40%
% of US land with land characterization and species distribution information available for resource management decision-making updated in the last 5 years **(BIMD)**	C	42.3%	34%	37%	40%	77%	80%	75%	-5%	80%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
% of complete historical bird banding records available electronically **(Pat. Center) (ARRA)**	A	UNK	UNK	0	0	0	50%	100%	+50%	TBD
% of the U.S. that is covered by at least one geologic map and is available to the public through the National Geologic Map Data Base **(NCGMP)**	C	44.13%	45.51%	47.71%	48.9%	48.9%	50%	51%	+1%	52%
% of regional and major topical studies for which interpretive and synthesis products are cited by identified partners and users within 3 years of study completion **(C&M)**	A	80%	80%	80%	80%	80%	80%	80%	0	85%
% of targeted geographic areas with temporal and spatial research, assessment and modeling of fish, wildlife and their habitats response to climate change to meet identified climate change adaptation planning and management needs **(NCCWSC) (Global Change)**	C	UNK	UNK	60% (3/5)	60% (6/10)	60% (6/10)	83% (25/30)	88% (35/40)	+75%	95% (38/40)
Comment	This measure has been reworded and has a new baseline. A single year authorization in 2008 funded the inaugural workshop and five demonstration projects with 3/5 completed in 2008. Funding in 2009 allowed for three regional workshops, a final NCCWSC national workshop to finalize the CSC concept, two additional 2008 projects completed, and establishment of the national center for a total of 6 of 10 planned accomplishments (6/10). Three CSCs were established in 2010, twenty-two multi-year projects developed with stake-holder/ partner input to achieve almost full geographic coverage of the U.S. (25/30) with the denominator reflecting the anticipated additional five regional CSCs for full national coverage. The transition from regional CSC development to research activities continues in 2011 with establishment of two more regional CSCs, completion of the 2009 projects (22), 2010 projects (9), and two climate change science workshops (2) in 2010. The denominator (40) is estimated from anticipated funding levels and research outcomes of approximately five major partnership outcomes per each CSC. The 2012 38/40 reflects establishment of the final three CSC and completion of all ongoing projects. During development, establishment of the partnerships and collaboration to develop the geographic focus for project was the intermediate outcome. Out year performance will be based on research in the targeted geographic areas identified by regional management partners and conservation cooperatives and prioritized at the national level and estimated to be five major efforts per CSC.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
% of surface area with temporal and spatial monitoring, research, and assessment/data coverage to meet land use planning and monitoring requirements (Number of completed eco-region assess-ments out of a total of 84 eco-regions) **(Global Change)**	C	48%	61% (51/84)	71% (60/84)	86% (72/84)	86% (72/84)	100% (84/84)	Completed in 2010	--	NA
% of targeted land cover trends national assessment syntheses, research plans, or science strategies that are published **(Global Change)**	C	UNK	UNK	UNK	20% (1/5)	20% (1/5)	40% (2/5)	60% (3/5)	+20%	80% (4/5)
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(WRD)**	A	UNK	820	754	521	649	681	616	-65	621
Comment for NAWQA	The decrease in products produce is a result of completing publication products planned in Cycle 2 (2002-2012) of NAWQA and winding down our level of reporting out as we ramp up with new data-collection activities for cycle 3 (2013-2023). The number of reports will be below average in the first years of Cycle 3 and then be above average by about 2016 because of the lag time between sample collection and report publication.									
# of retrievals of groundwater and surface-water quantity and quality data and Information **(WRD)**	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
# of water monitoring sites supported jointly with State, local, and Tribal Cooperators where surfacewater and groundwater quality and quantity data are measured to support water resource management decisions related to water supply, the health and recreational value of aquatic ecosystems, and floods and droughts **(COOP)**	A	UNK	21,800	21,800	20,600	20,600	20,000	19,500	-500	19,000
% of the Nation's 65 principal aquifers with monitoring wells used to measure responses of water levels to drought and climatic variations to provide information needed for water-supply decisionmaking **(SP) (GWRP)**	C	61%	60% (39/65)	58% (38/65)	62% (40/65)	62% (40/65)	62% (40/65)	62% (40/65)	0	62% (40/65)
% of U.S. with ground water availability status and trends information to support resource management decisions **(GWRP)**	C	UNK	8% (3/40)	8% (3/40)	13% (5/40)	13% (5/40)	15% (6/40)	18%* (7/40)	+3%	20% (8/40)
Total projected cost ($000)		**UNK**	**1,050**	**1,125**	**2.050**	**2,050**	**2,700**	**3,185**	**+485**	**3,960**
Actual cost per water status product (whole dollars)		**UNK**	**350,000**	**375,000**	**410,000**	**410,000**	**450,000**	**455,000**	**+5,000**	**495,000**
Comment	*Enhanced performance associated with the National Water Availability and Use Assessment effort will be realized in 2014 as this measure addresses studies that are completed as opposed to studies underway.									
% of the U.S. with completed, consistent water availability products that are used by partners for water resource management decision-making **(HNA)**	C	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	8% 180/2268	+8% 180/2268	16% 360/2268

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Total Projected Cost ($000)		**0**	**0**	**0**	**0**	**0**	**0**	**$4,900**	**+$4,900**	**$9,800**
Comment	The addition of $4,900,000 will allow for a nationwide effort of water availability information to be initiated. In the first year, critical information will be developed characterizing water flows, storage, use, water quality and ecological needs. This initiative will be targeted at completing a nationwide coverage of this information over the next decade. The denominator is established as follows: 378 (total number of HUC units) x 6 (the number of water availability indicators to be examined in each HUC: (1) surface water; (2) storage; (3) precipitation; (4) evapotranspiration; (5) ecological flows; (6) water use). The numerator is the total number of indicators addressed nationwide.									
% of U.S. with ground water quality status and trends information to support water resource management decisions **(NAWQA)**	C	UNK	18%	28%	38%	38%	48%	69%	+21%	100%
% of U.S. with streamwater quality data for status and trends assessment and information to support water resource management decisions **(NAWQA)**	C	UNK	18%	36%	53%	70%	87%	95%	+8%	95%
% of river basins that have streamflow stations **(SP) (NSIP)**	C	81% (1800/ 2223)	81% (1800/ 2223)	79% (1765/ 2223)	84% (1765/ 2102)	81.4% (1712/ 2102)	84% (1765/ 2102)	84% (1765/ 2102)	0	86% (1800/ 2102)
Total projected cost ($000)		**24,300**	**24,300**	**24,710**	**26,475**	**24,824**	**26,475**	**26,475**	**0**	**27,000**
Actual cost per water status product (whole dollars)		**13,500**	**13,500**	**14,000**	**14,500**	**14,500**	**15,000**	**15,000**	**0**	**15,000**
% of the proposed streamgages in the National Federal Streamgaging Network, providing streamflow information for interstate and international waters, streamflow forecasts, river basin outflows, sentinel watersheds, and water quality transport **(NSIP)**	C	UNK	62% (2940/4757)	62% (2940/4757)	64% (3030/4757)	64% (3030/4757)	64% (3030/4757)	64% (3030/4757)	0	63% (3000/4757)
Total projected cost ($000)		**UNK**	**39,690**	**41,160**	**43,935**	**43,935**	**45,450**	**45,450**	**0**	**45,000**

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Actual cost per water status product (whole dollars)		**13,500**	**13,500**	**14,000**	**14,500**	**14,500**	**15,000**	**15,000**	**0**	**15,000**
Discontinued streamgages, cableways, and ground-water well remediated **(NSIP) (ARRA)**	A	UNK	UNK	0	0	0	890	399	-491	Projects completed in 2011
# of streamgages upgraded with high data rate radios to increase frequency of radio transmission **(NSIP) (ARRA)**	C	UNK	UNK	4,500	4,900	4,505	5,300	6,900	+1,600	7,500
% of discharge measurements made with hydroacoustic instruments **(NSIP) (ARRA)**	C	UNK	UNK	35%	40%	67%	45%	70%	+25%	75%
% of targeted contaminants on annual target list for which methods are developed to measure environmental occurrence and assess potential health significance **(SP) (Toxic)**	C	85%	41% (78/188)	48% (138/287)	33% (76/230)	27% (62/232)	33% (64/196)	30% (59/196)	-3%	30% (59/196)
% of surface area of the conterminous U.S. for which high-resolution geospatial datasets are cataloged, managed, and available through *The National Map* **(SP) (NGP)**	C	UNK	99.71% (698/700)	99.86% (699/700)	99.86% (699/700)	99.86% (699/700)	100% (700/700)	100% (700/700)	0	100% (700/700)
Comment	The National Geospatial Program continues to maintain the geospatial data layers over the conterminous US. There are 7 data layers to maintain.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Square miles of high resolution elevation data collected in Priority Areas and added to the 1/9 arc-second (3 meter) National Elevation Dataset (NED) **(NGP) (Base Funds)**	A	UNK	UNK	93,153	58,000	66,000	58,000	29,000	-29,000	29,000
Square miles of high resolution, leaf off (<1m) orthoimagery data collected in the US and its territories added to the NGP orthoimagery database **(NGP) (Base Funds)**	A	UNK	UNK	79,751.35	75,000	1,346,629*	200,000	75,000	-125,000	75,000
Comment	* Increase due to National Geospatial-Intelligence Agency Border Program.									
Square miles of the US with updated high resolution elevation data **(NGP) (ARRA)**	A	UNK	UNK	UNK	21,000	0	35,000	35,000	0	NA
Comment	Performance is impacted by ARRA funding. Not a cumulative measure.									
Square miles of the US with high resolution, leaf off, <1m imagery data **(NGP) (ARRA)**	A	UNK	UNK	UNK	0	0	50,000	100,000	+50,000	NA
Comment	Performance will be impacted by ARRA funding. Not a cumulative measure.									
% of total cost FSA and USGS saved through partnering with other entities for imagery acquisition of 1-meter NAIP orthoimagery **(NGP)**	A	41% (4.43/10.8)	32% (2.3/7.2)	27%	36% (5.0/14.0)	18% (4.3/23.8)	40% (5.6/14)	0	-40%	0
Comment	The proposed reduction to *The National Map* partnerships program results in a decrease in performance.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
% of customers that identify or indicate (via a survey) that USGS NGP Outreach materials and activities (information and publications, conferences, training and workshops) met their needs/ requirements **(NGP)**	C	UNK	UNK	20%	20%	UNK	Baseline	30%	0	30%
Comment	In 2010, this measure will be rebaselined to determine the number of customers. The percent of customers is expected to increase in 2011 based on 2010 results.									
% of NGP partners reporting satisfaction with partnership agreements **(NGP)**	C	UNK	UNK	75%	75%	UNK	Baseline	80%	0	80%
% of US surface area with contemporary land cover data needed for major environmental monitoring and assessment programs **(SP) (Geography)**	C	94%	95% (286/300)	99.3% (298/300)	40% (120/300)	46% (213/463)	95% (440/463) complete the NLCD 2006 product	100% (463/463) Completes NLCD 2006; develop prototype for next NLCD product	+5%	15% (69/463) assumes next NLCD product remains path and row of imagery) complete of NLCD 2011
Comment	The current plan is to complete the NLCD 2006 update in early 2011. This product uses 2006 imagery and compares it to the NLCD 2001 data layers to provide an update of where land cover has changed over the five-year period. During 2011, the USGS working with Multi-Resolution Land Characteristics (MRLC) Consortium partners will begin efforts to develop prototype products for the next NLCD 2011. . Full scale NLCD 2011 production will begin in 2012.									
% of critical milestones successfully reached to support the LDCM launch schedule **(Geography)**	C	UNK	4% 1/23	35% 8/23	52% 12/23	52% 12/23	70% 16/23	83% 19/23	+13%	91% 21/23
Comment	The current number of critical milestones to be reached in support of the LDCM launch schedule is 23.									
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%
% satisfaction with scientific and technical products and assistance **(SP)**	A	91%	90%	93%	≥90%	95%	≥90%	≥90%	0	≥90%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Efficiency and Other Output Measures										
# of terabytes collected annually **(BUR) (LRS)**	A	287.5	288.9	261.3	270	158.8	165	165	0	165
# of terabytes managed cumulatively **(BUR) (LRS)**	C	3,425.3	4,255.9	3,840.6	4,300	3,010.9	4,000	4,000	0	4,000
# of gigabytes collected annually **(Global Change)**	C	2.8	2.8	2.8	2.8	2.9	2.8	2.8	0	2.8
# of gigabytes managed and distributed cumulatively **(Global Change)**	C	13.8	16.6	19.4	22.2	22.3	25	27	+2	29
# of systematic analyses and investigations completed **(BUR) (Geography)**	A	79	67	93	65	90	65	92	+27	92
Total projected cost ($000)		**43,012**	**46,441**	**24,180**	**16,900**	**23,400**	**16,900**	**23,920**	**+7,020**	**23,920**
Actual cost per analysis (whole dollars)		**544,452**	**693,149**	**260,000**	**260,000**	**260,000**	**260,000**	**260,000**	**0**	**260,000**
# of systematic analyses & investigations completed **(Global Change)**	A	UNK	UNK	7	91	93	121	153	+32	150
Total actual/ projected cost ($000)		--	--	**1,750**	**22750**	**23,250**	**30,250**	**38,250**	**+8,000**	**37,500**
Actual/projected cost per scientific report or other product (whole dollars)		--	--	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**0**	**250,000**
# of systematic analyses and investigations completed **(BRM)**	A	1,067	1,071	931	748	919	749	873	+124	895
Total projected cost ($000)		**213,400**	**214,200**	**186,200**	**157,080**	**192,990**	**157,290**	**183,330**	**+26,040**	**187,950**
Actual cost per analysis (whole dollars)		**200,000**	**200,000**	**200,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**
# of systematic analyses and investigations completed **(CRU)**	A	517	249	280	205	348	210	215	+5	215
Total projected cost ($000)		**103,400**	**49,800**	**56,000**	**43,050**	**73,080**	**44,100**	**45,150**	**+1,050**	**45,150**

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Actual cost per analysis (whole dollars)		**200,000**	**200,000**	**200,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**
# of formal workshops or training provided to customers **(BUR) (Geography)**	A	10	28	49	30	30	25	25	0	25
# of formal workshops or training provided to customers **(Global Change)**	A	UNK	UNK	3	15	15	30	42	+12	40
Total Projected Cost ($000)		--	--	**75**	**375**	**375**	**750**	**1,050**	**+300**	**1,000**
Projected Cost per Workshop (whole dollars)		--	--	**25,000**	**25,000**	**25,000**	**25,000**	**25,000**	**0**	**25,000**
# of formal workshops or training provided to customers **(CRU)**	A	41	25	31	13	18	20	20	0	20
% of CEN established relative to current target **(Global Change)**	C	UNK	UNK	11.5% (2.3/20)	20% (4/20)	20% (4/20)	45% (9/20)	65% (13/20)	+20%	65% (13/20)
Comment	This measure has been reworded and has a new baseline. Optimal network includes planning, negotiated collaborations, development and execution of pilot programs, regional stakeholder workshops, topical science workshops, regional topical assessments and uncertainty analyses, determination of data gaps for optimized network, and filling of gaps in infrastructure or capacity. Support services include oversight, data management, quality control, synthesis, and decision support. The 2012 network represents Phase 1 of a multi-year plan and only completes a portion of the optimized national network (roughly 5-10%)									
# of Regional *DOI CSCs* established **(Global Change)**	A	UNK	UNK	UNK	UNK	UNK	3	6	+3	2
# of records in the NBII Metadata Clearinghouse available to document biological data sets and information products **(BIMD)**	C	26,808	29,170	41,000	41,500	43,366	74,000	76,000	+2,000	78,000
Total projected cost ($000)		**580**	**580**	**580**	**580**	**572**	**570**	**570**	**0**	**570**
Actual cost per metadata record (whole dollars)		**21.63**	**19.88**	**14.14**	**13.97**	**13.19**	**7.70**	**7.50**	**-0.20**	**7.30**
Comment	Measure is cumulative; target reflects significant growth due to a large partner contribution.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
# of students complete degree requirements for MS, PhD, and post doctoral program under the direction and mentorship of Unit Scientists **(CRU)**	A	103	95	83	90	110	90	90	0	100
Cost of collection and processing of LiDAR data for coastal characterization and impact assessments **(C&M)**	C	.55	.57	.50	.45	.44	.39	.32	-.07	.31
# of gigabytes of LiDAR data collected annually **(C&M)**	A	UNK	UNK	UNK	100	100	300	300	0	300
# of systematic analyses and investigations completed **(C&M)**	A	8	218	200	180	200	200	210	+10	225
Total projected cost ($000)		**36,000**	**33,745**	**34,549**	**35,000**	**35,000**	**43,000**	**46,000**	**+3,000**	**46,000**
Actual projected cost per analysis (whole dollars)		**UNK**	**155,000**	**173,000**	**205,880**	**175,000**	**215,000**	**219,000**	**+4,000**	**205,000**
# of systematic analyses and investigations completed for Coastal and Marine Spatial Planning **(C&M)**	A	UNK	UNK	UNK	UNK	UNK	UNK	10	+10	15
Annual production of geologic maps for the Nation (summed and represented as a % of US) made available to the public through the National Geologic Map Data Base **(NCGMP)**	A	5.57%	5.37%	4.15%	2.9%	2.9%	2%	2%	0%	2%
Total projected cost ($000)		**UNK**	**UNK**	**23,458**	**23,460**	**24,425**	**24,812**	**24,904**	**+92**	**24,904**
Actual projected cost per square mile (whole dollars)		**UNK**	**UNK**	**1,750**	**1,750**	**1,750**	**1,750**	**1,750**	**0**	**1,750**

End Outcome Goal 2.4: Improve the understanding of Energy and Mineral Resources to Promote Responsible Use and Sustain the Nation's Dynamic Economy.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
% of targeted science products that are used by partners or customers for land or resource decision making **(SP)**	A	87.5%	99%	95%	≥90%	94%	≥90%	≥90%	0	≥90%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of energy and mineral resource information and systematic analyses needed by land and resource mangers for informed decision making**										
# of targeted basins/areas with energy resource assessments available to support management decisions **(SP) (ERP)**	A	6	5	5	5	6	5	5	0	5
% of targeted non-fuel mineral commodities for which up-to-date deposit models are available to support decision making **(SP) (MRP)**	C	0%	0%	7%	20%	20%	53%	73%	+20%	93%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (11/11)	100% (11/11)	100% (8/8)	100% (8/8)	100% (9/9)	100% (9/9)	100% (8/8)	0	100% (9/9)
% satisfaction with scientific and technical products and assistance **(SP)**	A	97.5%	97%	97%	≥80%	97%	≥80%	≥80%	0	≥80%
Efficiency and Other Output Measures										
# of gigabytes collected annually **(BUR) (ERP)**	A	158.048	37.409	1.173	3.1189	17.6482	1.240	3.4090	+2.169	3.4295
# of metadata records **(BUR) (Data Preservation)**	C	UNK	UNK	UNK	Baseline	600,000	600,000	TBD	--	TBD
# of systematic analyses and investigations completed **(BUR) (ERP)**	A	5	5	5	5	6	5	5	0	6

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Total projected cost ($000)		**9,900**	**7,800**	**13,750**	**13,750**	**13,750**	**13,750**	**13,750**	**0**	**13,750**
Actual projected cost per analysis (whole dollars)		**.98M**	**1.3M**	**2.75M**	**2.46M**	**2.75M**	**2.75M**	**2.75M**	**0**	**2.75M**
# of systematic analyses and investigations completed **(BUR) (MRP)**	A	6	6	3	3	3	4	3	-1	3
Total projected cost ($000)		**25.8M**	**22.2M**	**14.1M**	**14.7M**	**14.7M**	**23.6M**	**30.3M**	**+6.7M**	**68.1M**
Average cost per systematic analysis or investigation (whole dollars)		**4.3M**	**3.7M**	**4.7M**	**4.9M**	**4.9M**	**5.9M**	**10.1M**	**+4.2M**	**22.7M**
Comment	Reported cost per systematic analysis is the average of the actual (multi-year) cost of the systematic analyses completed in each fiscal year.									
# of outreach activities provided to customers **(BUR) (ERP)**	A	8	8	8	8	8	9	10	+1	10
# of formal workshops or training provided to customers **(BUR) (MRP)**	A	8	7	6	6	6	8	6	-2	6
# of mineral commodity reports available for decisions **(MRP)**	A	690	717	649	700	707	720	700	-20	700

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
% of communities/ Tribes using DOI science on hazard mitigation, preparedness and avoidance for each hazard management activity **(SP)**	C	48%	50%	53%	53%	54%	50%	50%	0	50%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Comment	This measure is an aggregate of three hazard programs. The baseline in the Volcano Hazard Program was recalculated as 300 counties and county-equivalent communities for fiscal year 2010. Current target has the new baseline figure.									
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
# of areas for which detailed hazard assessments are completed **(SP)**	C	49	52	53	55	57	57	59	+2	61
# of metropolitan regions where Shakemap is incorporated into emergency procedures **(SP) (EHP)**	A	5	5	5	5	5	5	5	0	5
% completion of optimal monitoring for moderate to high hazard areas* **(EHP)**	C	10.3%	11.2%	11.5%	11.7%	12.7%	18.5%	24.2%	+5.7%	24.3%
% of moderate to very high threat volcanoes with published hazard assessments (denominator reset to 101) **(SP) (VHP)**	C	UNK	UNK	UNK	47.5% (48/101)	46.5%	47.5% (48/101)	48.5% (49/101)	+1%	48.5% (49/101)
# of monitoring and telemetry nodes upgraded (e.g., analog to digital conversion, added sensors, improved power systems, upgraded radio transmitters and receivers) **(VHP) (ARRA)**	A	UNK	UNK	12	13	15	46	95	+49	0
% of very high threat volcanoes with optimal level monitoring (X number of 18) **(VHP) (ARRA)**	C	UNK	UNK	22.2%	22.2%	22.2%	22.2%	33.3%	+11.1%	44.4%
# of GSN next-generation systems deployed (of 87 needed) **(GSN) (ARRA)**	C	0	0	9	22	22	40	54	+14	87

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (4/4)	100% ((239/239)	100% (218/218)	100% (230/230)	100% (236/236)	100% (247/247)	100% (249/249)	0	100% (249/249)
% satisfaction with scientific and technical products and assistance **(SP)**	A	UNK	87%	87%	≥80%	87%	≥80%	≥80%	0	≥80%
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (EHP)**	A	2	152	132	140	146	157	159	+2	159
Total projected cost ($000)		**UNK**	**27,664**	**24,024**	**25,480**	**26,572**	**28,574**	**28,938**	**+364**	**28,938**
Actual cost per analysis(whole dollars)		**UNK**	**182,000**	**182,000**	**182,000**	**182,000**	**182,000**	**182,000**	**0**	**182,000**
# of systematic analyses and investigations completed **(BUR) (VHP)**	A	1	75	71	75	99	75	75	0	75
Total projected cost ($000)		**500**	**22,500**	**21,300**	**22,500**	**29,700**	**22,500**	**22,500**	**0**	**22,500**
Actual cost per analysis (whole dollars)		**500,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**0**	**300,000**
# of systematic analyses and investigations completed **(BUR) (LHP)**	A	1	16	15	15	15	15	15	0	15
Cumulative number of ANSS seismic monitoring stations* **(EHP) (ARRA)**	C	723	786	805	822	886	1,292	1,692	+400	1,700
# of stations operated* **(EHP)**	C	2,722	2,731	2,767	2,836	2,848	2,900	3,038	+138	3,050
Comment	* The strong performance that is projected for earthquake monitoring measures in 2010 and 2011 is due to ARRA funding for seismic network upgrades (+766 stations), plus multi-hazard funding for additional stations in the Pacific Northwest in 2011 (+50 stations).									
# of monitoring stations operated by VHP	C	694	714	734	737	743	743	758	+15	775

Goal Performance Table

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
# of stations upgraded with ARRA funds per year **(VHP)**	A	UNK	UNK	UNK	15	2	46	95	+49	NA
Total # of stations operated and/or upgraded by **VHP**	A	UNK	UNK	UNK	752	745	789	853	+64	NA
# of stations operated **(Geomag)**	C	14	14	14	13	13	13	13	0	13
# of stations operated **(GSN)**	C	90	95	99	100	100	100	100	0	100
% of moderate to very high threat volcanoes with at least basic real time monitoring **(VHP)**	C	UNK	UNK	UNK	37.6% (38/101)	37.6% (38/101)	37.6% (38/101)	39.6% (40/101)	+2%	40.6% (41/101)
% data availability for real-time data from the GSN **(GSN)**	A	88%	87.8%	87%	84%	87.5%	88%	87%	-1%	90%

End Outcome Goal 5.1: Increase Accountability

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
Obtain unqualified audit **(SP)**	A	Unqualified Opinion	Unqualified Opinion	Unqualified Opinion	Unqualified Opinion	Unqualified Opinion	Unqualified Opinion	Unqualified Opinion	-	Unqualified Opinion
Establish and maintain an effective, risk-based internal control environment as defined by the Federal Manager's Financial Integrity Act (FMFIA) and revised OMB Circular A-123 **(SP)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%
Intermediate Outcome Measures and Bureau and Outcome Measures **Improved Financial Management**										

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Corrective actions: Percent of material weaknesses, and material non-compliance issues that are corrected on schedule **(SP)**	A	UNK	UNK	UNK	100%	100%	100%	100%	0	100%
Corrective Actions: Percent of established targets in Financial Performance Metrics met as defined in FAM No. 2003-015. **(SP)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%

End Outcome Goal 5.2: Advance Modernization/Integration

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
Percent of IT systems that have Certification and Accreditation (C&A) and are maintaining C&A status **(SP)** **(EIS&T)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%
Intermediate Outcome Measures and Bureau and Outcome Measures E-Government and Information Technology Management										
Efficient IT Management: Score achieved on the OMB Enterprise Architecture Framework **(SP)** **(EIS&T)**	A	Level 3	Level 4 – complete Level 3 – Use and Results	Level 4 on "Completion" "Use," and "Results" categories	Level 4 in all areas	Level 4 in all areas	Level 4 in all areas	Level 4 in all areas	0	Level 4 in all areas
Efficient IT Management: Stage achieved on the GAO IT Investment Management Framework **(SP)** **(EIS&T)**	A	63% stage 3	70% stage 3	100% stage 3	100% stage 3	100% stage 3	50% stage 3	25% stage 4	-25%	25% stage 4

Goal Performance Table

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Comment	Although USGS plans to achieve efficiencies in 2011, a reduction in program performance is expected.									
Efficient IT Management: Score achieved on the NIST Federal IT Security Assessment Framework **(SP) (EIS&T)**	A	3.37	3.5	3.99	5.0	2.0	5.0	4.0	-1.0	4.0
Comment	Although USGS plans to achieve efficiencies in 2011, a reduction in program performance is expected.									
Implement Records Management Strategy: % of all bureaus and offices developing consistent records management policy **(SP) (EIR)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%
IT Investment Management Annual % of USGS IT investments reviewed, approved, and monitored through the CPIC process. **(EIS&T)**	A	100%	100%	100%	100%	100%	100%	100%	0	100%
% of earth science instructors in the U.S., K-16, using USGS educational materials **(EIR)**	A	UNK	UNK	Baseline	K-12 = 32%; Levels 13-16 = 78%	K-12 = 55% Levels 13-16 = 45%	K-12 = 32%; Levels 13-16 = 78%	K-12 = 32%; Levels 13-16 = 78%	0	K-12 = 32%; Levels 13-16 = 78%
% of customers satisfied with service from USGS IT Service Desk **(EIS&T)**	A	94%	95.9%	96.7%	94% (4559/ 4850)	96.64%	95%	90% (4365/ 4850)	-5%	90% (4365/ 4850)
Comment	Although USGS plans to achieve efficiencies in 2011, a reduction in program performance is expected.									
% of identified USGS security incidents that receive corrective action within timeframes required by the DOI Incident Response Policy **(EIS&T)**	A	75%	95%	86%	100%	90%	90%	100%	+10%	100%
Comment	With an increased emphasis on incident response and adhering to Departmental policy, the USGS Computer Security Incident Response Team will be targeting 100% compliance with reporting requirements. With the increasing risk of unauthorized access to information technology systems and employee personal information, it is critical the USGS respond with established timeframes to further protect USGS data and systems.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Total USGS public web content managed by the enterprise web infrastructure **(EIR)**	A	UNK	UNK	UNK	Baseline	197 public web sites hosted by Enterprise Web infrastructurewith a total of 1130.3 Gb of storage provided for those sites on NatWeb servers.	TBD	TBD	0	TBD
Comment	In 2009, the USGS is working on a methodology for a baseline for this measure.									
Total # of internships and fellowships supported and/or facilitated by the USGS educational program **(EIR)**	A	55	70	55	55	42	175	85	-90	75
Comment	The proposed reduction in 2011 results in a decrease in program performance.									
Efficiency and Other Output Measures										
# of new and legacy information products added to the USGS publications database **(EIR)**	C	70,351	71,717	44,502	67,500	73,806	75,000	76,000	+1,000	76,000
Comment	The planned increase is the natural addition of new series publications released annually.									
# of online bibliographic records **(EIR)**	A	6,381	4,992	2,444	6,381	4,569	4,500	4,500	0	4,500
Intermediate Outcome Measures and Bureau and Outcome Measures **Human Capital Management**										
Worker Competency: % of employees who have resolved competency gaps in specified occupational groups identified as critical occupations in the Department **(SP)**	C	77%	77%	75%	75%	76.1%	76%	76%	0	76%
Diversity: The % of managers who have completed the 4-hour required minimum annual diversity/EEO training	A	UNK	39.2%	78%	30%	>33.59%	85%	85%	0	85%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Diversity: The # of MD-715 identified deficiencies that have been corrected	A	UNK	3	3	1	0	1	1	0	1
Safe Workplace: 3% annual reduction in the total injury incidence rate **(SP)**	A	2.838 injuries per 100 employees	2.586 injuries per 100 employees	3.086 injuries per 100 employees	(-3%) 2.993 injuries per 100 employees	2.599	2.904	(-3%) 2.817 injuries per 100 employees	(-3%) -.087 injuries per 100 employees	(-9%) 2.724 injuries per 100 employees
Safe Workplace: 3% annual reduction in the lost time injury incidence rate **(SP)**	A	.788 injuries per 100 employees	.669 injuries per 100 employees	.786 injuries per 100 employees	(-3%) .762 injuries per 100 employees	.491	.739	(-3%) .717 injuries per 100 employees	(-3%) -.022 injuries per 100 employees	(-9%) .693 injuries per 100 employees
Collaboration Capacity: # of volunteer hours per year supporting DOI mission activities **(SP)**	A	UNK	138,761	143,792	144,000	221,394	221,500	TBD	--	TBD
Comment	The USGS is currently rebaselining this measure based on new reporting capabilities being put in place.									
Cooperative Conservation Internal Capacity: # of employees trained in collaboration and partnering competencies	C	UNK	150 FTE	4,106 FTE	4,500 FTE	4,424 FTE	4,000 FTE	4,000 FTE	0	4,000 FTE
Cooperative Conservation Internal Capacity: % of organizations that have trained and developed employees in collaboration and partnering competencies **(SP)**	C	UNK	41%	46%	60%	48%	11%	45%	+34%	60%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Cooperative Conservation External Capacity: # of conservation projects that actively involve the use of knowledge and skills of people in the area, and local resources in priority setting, planning, and implementation processes **(SP)**	A	UNK	90	91	92	92	96	100	+4	100
Museum Property: Percent total reduction of cataloguing and accessioning time **(SS)**	A	UNK	UNK	UNK	25%	25%	25%	25%	0	25%
Intermediate Outcome Measures and Bureau and Outcome Measures Organizational Reviews and Acquisitions										
Increase Competition: Percentage of eligible service contract actions over $25,000 awarded as performance-based acquisitions **(SP)**	A	25%	50%	57.1%	50%	52.8% of actions 66.9% of dollars	50%	50%	0	50%
Intermediate Outcome Measures and Bureau and Outcome Measures Performance-Budget Information										
% of programs with demonstrated use of performance measures in budget justifications and decisions **(SP)**	A	UNK	100%	100%	100%	100%	100%	100%	0	100%
% of programs that can estimate marginal cost of changing of performance **(SP)**	A	UNK	100%	100%	100%	100%	100%	100%	0	100%
Intermediate Outcome Measures and Bureau and Outcome Measures Facilities Improvement										

Goal Performance Table

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Overall condition of owned buildings and structures (as measured by the FCI) that are mission critical and mission dependent (as measured by the API), with emphasis on improving the condition of assets with critical health and safety needs **(SP) (Deferred Maintenance)**	A	0.150	0.124	0.134 68,4004/ 510,141	0.133 (67,247/ 509,616)	0.134 (71,543/ 532,365)	0.098 (52,289/ 532,365)	0.078 (41,515/ 532,365)	-0.020	0.072 (38,342/ 532,365)
Overall condition of owned buildings and of structures (as measured by the FCI) that are mission critical and mission dependent (as measured by the API), with emphasis on improving the condition of assets with critical health and safety needs **(SP) (Construction)**	A	UNK	UNK	UNK	UNK	UNK	UNK	0.076 (40,265/ 532,365)	UNK	0.070 (37,092/ 532,365)
Percent change in the Operating Costs (operations and maintenance costs) per square foot of buildings that are "Not-Mission Dependent" (NMD) as reported in the Federal Real Property Profile (FRPP) in the current fiscal year compared to the previous fiscal year. **(SP)**	A	$3.15/sf 0%	$3.03/sf -1.6%	$ 2.38/sf -1%	$2.33/sf 3%	$1.11/sf -53%	$1.08/sf -3%	$1.04/sf -3%	$0.04/sf -3%	$2.07/sf -3%

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Percent change in the total number of buildings (office, warehouse, laboratory, and housing) reported as "Under Utilized" or "Not Utilized" in the Federal Real Property Profile (FRPP) in the current fiscal year compared to the previous fiscal year.	A	UNK	83%	-5%	-7.9%	-63%	-5%	-5%	0	-5%
Improvement in Bureau Facilities Condition Index (FCI)***(ARRA)**	A	UNK	0.12	0.13	0.12	0.12	0.10	0.07	-0.003	0.06
Comment	*FCI is determined by combining funding for Deferred Maintenance – Facilities ($29.4M) and Construction ($18.3M)									
Percent of assets targeted for disposal that were disposed **(SP)**	A	26%	100%	11.7% (17/2)	24% (25/6)	48% (25/12	17% (23/4)	42% (19/8	+25%	27% (11/3)
PART Efficiency and Other Output Measures										
# of bureau condition assessments in progress or completed (within a 5-year cycle **(Facilities)**	C	+5 Cum 14	+9 Cum 23	+10 Cum 33	+9 Cum 42	+4 Cum 37	+10 Cum 10	+10 Cum 20	+10	+10 Cum 30
Comment	Of the nine (9) assessments planned in 2009 four (4) were completed. The remaining five (5) assessments were delayed for a year due to ARRA projects being started under the current A&E contract. These five (5) assessments are part of the ten (1) assessments scheduled in 2010. A new 5-year cycle begins in 2010.									
Number of buildings (office, warehouse, laboratory, and housing) reported as "Under /Not Utilized" USGS owned and direct lease **(Facilities)**	A	13	21	20	15	7	6	5	-1	4
Total Operations and Maintenance cost of Not-Mission Dependent Building **(Facilities)**	A	159	149	$24	$23	$19.6	$19.1	$18.5	-$0.6	$19
Total Square Footage of buildings that are "Not-Mission Dependent" as reported in the FRPP **(Facilities)**	A	51	49	8.7	8.4	17.7	17.7	17.7	-0	7.7
Comment	In 2009 multiple assets were reclassified as Mission Dependant-Not Critical. This reduced the square footage of the Not-Mission Dependant assets.									

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New Energy Frontier

	2009 Enacted	2009 Recovery Act	2010 President's Budget	2011 DOI-wide Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
New Energy Frontier							
Renewable Energy – Wind and Solar ($000)	0	0	1,000	0	0	1,000	0
FTE	*0*	*0*	*1*	*0*	*0*	*1*	*0*
Renewable Energy – Biofuels ($000)	0	0	1,000	0	0	1,000	0
FTE	*0*	*0*	*1*	*0*	*0*	*1*	*0*
Renewable Energy – Geothermal ($000)	0	0	1,000	0	0	1,000	0
FTE	*0*	*0*	*1*	*0*	*0*	*1*	*0*
Alternative Energy-Wind							
Energy Resources Program ($000)	0	0	0	0	+ 3,000	3,000	+ 3,000
FTE	*0*	*0*	*0*	*0*	*+ 5*	*5*	*+ 5*
Total Requirements ($000)	**0**	**0**	**0**	**0**	**+ 3,000**	**6,000**	**+ 3,000**
Total FTE	***0***	***0***	***0***	***0***	***+5***	***8***	***+ 5***

Summary of 2011 Program Changes for New Energy Frontier- Wind

Request Component	($000)	FTE
• Energy Resources Program	+3,000	+5
TOTAL Program Changes	**+3,000**	**+5**

Justification of 2011 Program Changes

The 2011 budget request for a New Energy Frontier - Wind is $6,000,000 and 8 FTE, a net program change of +$3,000,000 and + 5 FTE from the 2010 Enacted level.

New Energy Frontier - Alternative Energy Studies - Wind (+$3,000,000 / 5 FTE)

The U.S. Geological Survey (USGS) will assess the impacts to wildlife associated with new technologies used for the development of wind energy and work closely with Interior agencies (e.g., U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, and the Minerals Management Service) to provide the scientific information they need to make informed decisions concerning the permitting, implementation and operation of energy-generating wind facilities on public lands.

USGS research, modeling, and monitoring will assess the ecological impacts to fish and wildlife associated with the widespread development of wind energy. Ecological and geographic studies will examine impacts to fish and wildlife from direct strikes, habitat fragmentation, and construction and maintenance of infrastructure. The infrastructure needed for energy capture and transmission would include wind turbines and generating facilities as well as towers, cables, and roads, sea bed corridors, and marine traffic. USGS science will be directed toward studying causes and identifying solutions that will minimize risk to fish and wildlife and assess the ecological impacts of projected large-scale development of wind-farms in the Great Plains and offshore in the Atlantic. In addition, USGS science will provide technical support, establish a comprehensive data management structure, facilitate collaboration, and ensure long-term viability of information products that contribute to the Nation's understanding of the management and effects of wind energy infrastructure and products. In 2011, USGS efforts will begin in the Great Plains and offshore Cape Cod region, and will work toward developing an assessment methodology that can be applied nationwide. These proposed efforts will build on work that is being proposed in 2010.

The research, modeling, and monitoring activities associated with this effort will be an integrated effort by scientists from several USGS programs.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
# of systematic analyses and investigations completed (ERP)	0	0	0	0	0	0	0	+1
# of outreach activities provided to customers **(BUR) (ERP)**	0	0	0	0	0	1	+1	0

Program Overview

The Nation faces simultaneous challenges from an increasing need for alternative energy resources and growing demands to minimize environmental effects associated with alternative energy resource development and utilization. The USGS addresses these challenges by conducting research to better understand the ecological impacts of alternative energy resource occurrence and use. The USGS conveys results from these studies to land and resource managers and policymakers in support of the Department's goal of improving understanding of the impacts of developing and utilizing alternative energy resources. This information is used to plan for a secure energy future and to allow for the strategic use and evaluation of resources. Major consumers of these products are the Department's land and resource management bureaus.

The United States is poised for significant increases in wind-energy production in the Great Plains and in several offshore locations. Research and assessments are needed to ensure that

the development of wind energy can occur while minimizing negative impacts to birds, bats, other wildlife, and natural ecosystems.

2011 Program Performance

In order to convey the results of studies and/ or products related to identifying solutions that will minimize the risk of ecological impacts of large scale wind farms, one additional workshop or training will be conducted in 2011 as part of this effort.

Performance Overview Table

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (ERP)**	A	5	5	5	5	6	5	5	0	6
# of outreach activities provided to customers **(BUR) (ERP)**	A	8	8	8	8	8	9	10	+1	10

Climate Change Adaptation

	2009 Enacted	2010 Enacted	2011				Change From 2010 (+/-)
			DOI-wide Changes (+/-)	Tech. Adjust-ment (+/-)	Program Changes (+/-)	Budget Request	
Climate Change Adaptation ($000)							
Carbon Sequestration Assessment	3,000	10,095	-120		+2,000	11,975	+1,880
FTE	*2*	*12*			*+2*	*14*	*+2*
NCCWSC and the DOI Climate Science Centers (DOI CSCs)	10,000	15,143	-180		+8,000	22,963	+7,820
FTE	*10*	*30*			*+8*	*38*	*+8*
Science Applications & Decision Support	1,500	1,514	-18		+1,000	2,490	+982
FTE	*6*	*6*			*+2*	*8*	*+2*
Total Requirements ($000)	***14,500***	***26,752***	***-318***		***+11,000***	***37,428***	***+10,682***
Total FTE	***18***	***48***			***+12***	***60***	***+12***

Summary of 2011 Program Changes for Climate Change Adaptation

Request Component	($000)	FTE
• Carbon Sequestration Assessment	+2,000	+2
• NCCWSC and the DOI Climate Science Centers (DOI CSCs)	+8,000	+8
• Science Applications & Decision Support	+1,000	+2
TOTAL Program Changes	**+11,000**	**+12**

Justification of 2011 Program Changes

The 2011 budget request for the Climate Change Adaptation initiative is $37,428,000 and 60 FTE, a net program change of +$11,000,000 and +12 FTE from the 2010 Enacted level.

Climate Impacts Adaptation Initiative (+$11,000,000 / +12 FTE)

Developing the next generation of scientists is a priority for the USGS. Utilizing existing programs such as the Cooperative Fish and Wildlife program, EDMAP in National Cooperative Geological Mapping (NCGMP), and grants to universities, USGS is providing the opportunities for college students to work on science projects important to the mission of the Department of the Interior. USGS will involve students in this initiative through these programs.

Biological Carbon Sequestration Assessment (+$2,000,000) — An increase of $2.0 million in the Climate initiative is requested for USGS to continue the implementation of the methodology for the national assessment of biological carbon sequestration developed in previous years. These activities were authorized in the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), which calls for comprehensive assessment of geologic and biologic carbon sequestration to enable decisionmakers to evaluate the full range of sequestration options. The 2010 budget for sequestration activities is $10.0 million, which includes $5.0 million for geologic carbon sequestration assessment and $5.0 million for biological carbon sequestration assessment. The 2011 increase of $2.0 million specifically supplements the $5.0 million received in 2010 for ongoing and increased activities in biological carbon sequestration.

In 2011, funds for biologic carbon sequestration will be used to (1) implement the methodology for assessment of the Nation's resources for biological carbon sequestration developed in 2009 and 2010; (2) continue to utilize mechanisms for consultation concerning biological carbon sequestration resource assessment with Interior resource managers and stakeholders from other Federal and State agencies and from the private sector, including consultations with stakeholders and the interagency science advisory panel that was initiated at the end of 2009 and continued into 2010 and onward; and (3) address technical issues and data gaps identified in 2010 that impact uncertainties and risks in the ability to assess biological carbon sequestration.

NCCWSC and the DOI Climate Science Centers (+$8,000,000) — Management decisions made in response to climate change impacts must be informed by science and require that scientists work in tandem with those managers who are confronting climate change impacts and evaluating options to respond to such impacts. Pursuant to P.L. 110-161, the United States Geological Survey (USGS) began the development of the National Climate Change Wildlife Science Center (NCCWSC). A major component of NCCWSC is eight Department of the Interior Regional Climate Science Centers with a primary focus on providing climate change impact data and analysis geared to the needs of natural and cultural resource managers as they develop adaptation strategies in response to climate change. These centers are being developed in close collaboration with Interior agencies and other Federal, State, university, and non-governmental partners.

Part of the increase to USGS of $8.0 million for the DOI Climate Science Centers (DOI CSCs) will be used to create and staff two new centers, adding to the three centers established in 2010. The remainder of the increase will fulfill the climate change research mission of the DOI CSCs. The centers will provide direct contact and interaction between scientists and fish and wildlife, land, water, and cultural resource managers to develop and evaluate models and tools for implementation in iterative adaptive management approaches based on sound science. National coordination of research and modeling at the regional centers will ensure uniformity of downscaling and forecasting models and standardized information to support management of

fish and wildlife, water, land use, and cultural resource resources for regional partnership collaborations including the Landscape Conservation Cooperatives (LCCs); one of the primary DOI CSCs partners. Work at the DOI CSCs is crucial to successfully accomplishing its mission, which is to provide the science and technical support needed to help natural and cultural resource managers anticipate climate change impacts and evaluate options that will facilitate adaptation to changing landscapes. The LCCs are the Department's science application centers, which will provide a collaborative environment for bureaus and other partners to utilize DOI CSCs science in their monitoring and adaptation activities and provide feedback to the regional centers for future research needs.

In 2011, funds for the DOI CSCs will be used to: (1) work in close partnership with the natural resource management communities to understand high priority science needs, and what is needed to fill those knowledge gaps; (2) work with the scientific community to develop science information and tools that can inform management strategies for responding to climate change; (3) deliver these relevant tools and information timely and directly to resource managers. Partnership efforts are integral to activities and outcomes at the DOI CSCs and include among others, LCCs, USDA-Forest Service Climate Change Resource Center, Climate Change Impacts on Tribal Trust Species and Resources, NASA, NOAA and EPA.

Science Applications & Decision Support (+$1,000,000) — In 2011, the Science Applications and Decision Support element of the USGS Global Change program will continue its efforts to develop decision-support tools that enable resource managers and policymakers to cope with and adapt to a changing climate. Collaboration with a number of academic institutions including Cornell University, Colorado State University, the Massachusetts Institute of Technology (MIT), and Montana State University has been established and spans the fields of social science, natural resources, artificial intelligence, statistics, and earth sciences. Decision-support will be developed through new partnerships, enhancement of existing collaborations, and in training the next generation of applications scientists.

Funding in 2011 will also focus on the continued development and expansion of a comprehensive interdisciplinary capacity for addressing climate impacts and policy issues for multiple resource management in the Northern Rocky Mountain Landscape and in the Columbia River Basin. The DOI CSCs have a focused mission of climate change effects on wildlife, ecosystems, and natural resources including water and the LCCs are similarly focused on building collaborations among fish and wildlife managers for application of adaptation strategies through adaptive management practices. This interdisciplinary approach will encourage collaboration among these programs to provide applications and decision support for fish and wildlife issues, and will also allow partnerships with other Federal agencies, including NOAA and NASA, regional USGS biology and water discipline centers, and local resource managers to address multiple management issues of concern in the Northern Rockies ecoregion and in the Columbia River Basin (water resource management, carbon sequestration, human infrastructure stability, etc.). These efforts will provide a science and applications framework within which the DOI CSCs, the LCCs, and other programs can learn from and leverage the information and capacities developed by the others. The first of a series of these collaborations began in Bozeman, Montana in 2010, continuing into 2011-12 and will focus on the Northern Rockies landscape. It is the pilot for demonstrating and delivering regional climate impact services in the Northern Rockies, across the Department of the Interior, and throughout the Nation. The work conducted by the Northern Rockies Center in 2010 and in 2011 will include collaborative work with several universities across the Nation including Colorado State University, Cornell University, and MIT in developing decision support tools geared to natural

resource management in a changing climate. The experiences of the scientists and managers working in this pilot in the Northern Rockies will be drawn upon for establishing similar efforts in other regions of the Nation in 2011 (for example the Columbia River Basin).

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan+ Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
Improve the understanding of National Ecosystems and Resources through interdisciplinary assessments								
# of systematic analyses and investigations *Carbon Sequestration*	UNK	UNK	UNK	4	4	6	+2	2
Total actual/ projected cost ($000)	**--**	**--**	**--**	**$800**	**$800**	**$1,200**	**+$400**	**$400**
Actual/projected cost per systematic analysis (whole dollars)	**--**	**--**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**0**	**$200,000**
# of systematic analyses and investigations *DOI CSCs*	UNK	5	10	30	30	45	+15	15
Total actual/ projected cost ($000)	**--**	**$1,250**	**$2,500**	**$7,500**	**$7,500**	**$11,250**	**+$3,750**	**$3,750**
Actual/projected cost per systematic analysis (whole dollars)	**--**	**$250,000**	**$250,000**	**$250,000**	**$250,000**	**$250,000**	**--**	**--**
# of formal workshops and training provided to stakeholders and customers *Carbon Sequestration*	UNK	UNK	UNK	3	3	5	+2	+2
Total actual/projected cost ($000)	**--**	**--**	**--**	**$240**	**$240**	**$400**	**+160**	**+160**
Actual/projected cost per workshop (whole dollars)	**--**	**--**	**$80,000**	**$80,000**	**$80,000**	**$80,000**	**0**	**$80,000**
# of formal workshops and training provided to customers *DOI CSCs*	UNK	1	4	15	15	20	+5	5

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan+ Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
Total actual/projected cost ($000)	--	**$100**	**$150**	**$375**	**$375**	**$500**	**+$125**	**$125**
Actual/projected cost per workshop (whole dollars)	**$25,000**	**$25,000**	**$25,000**	**$25,000**	**$25,000**	**$25,000**	**0**	**--**
Comments	Science and decision-making boards and stakeholder workshops will determine user needs and delivery requirements. Out-year costs per tool may decrease as knowledge base on customer requirements increases. Cost per unit is an average from the programs contributing to the DOI CSCs.							
% of targeted geographic areas with temporal and spatial research, assessment and modeling of fish, wildlife and their habitats response to climate change to meet identified climate change adaptation planning and management needs (NCCWSC)	UNK	60% (3/5)	60% (6/10)	83% (25/30)	83% (25/30)	88% (35/40)	+75%	95% (38/40)
Comments	This measure has been reworded and has a new baseline. A single year authorization in 2008 funded the inaugural workshop and five demonstration projects with 3/5 completed in 2008. Funding in 2009 allowed for three regional workshops, a final NCCWSC national workshop to finalize the CSC concept, two additional 2008 projects completed, and establishment of the national center for a total of 6 of 10 planned accomplishments (6/10). Three CSCs were established in 2010, twenty-two multi-year projects developed with stake-holder/ partner input to achieve almost full geographic coverage of the U.S. (25/30) with the denominator reflecting the anticipated additional five regional CSCs for full national coverage. The transition from regional CSC development to research activities continues in 2011 with establishment of two more regional CSCs, completion of the 2009 projects (22), 2010 projects (9), and two climate change science workshops (2) in 2010. The denominator (40) is estimated from anticipated funding levels and research outcomes of approximately five major partnership outcomes per each CSC. The 2012 38/40 reflects establishment of the final three CSC and completion of all ongoing projects. During development, establishment of the partnerships and collaboration to develop the geographic focus for project was the intermediate outcome. Out year performance will be based on research in the targeted geographic areas identified by regional management partners and conservation cooperatives and prioritized at the national level and estimated to be five major efforts per CSC.							
% of CEN established relative to current target	UNK	11.5% (2.3/20)	20% (4/20)	45% (9/20)	45% (9/20)	65% (13/20)	+20%	65% (13/20)
Comments	This measure has been reworded and has a new baseline. Optimal network includes planning, negotiated collaborations, development and execution of pilot programs, regional stakeholder workshops, topical science workshops, regional topical assessments and uncertainty analyses, determination of data gaps for optimized network, and filling of gaps in infrastructure or capacity. Support services include oversight, data management, quality control, synthesis, and decision support. The 2012 network represents Phase 1 of a multi-year plan and only completes a portion of the optimized national network (roughly 5-10%)							
# of *DOI CSCs* established	UNK	UNK	UNK	3	3	6	+3	2
Comments	These centers are located in loosely geographic areas to ensure national coverage to meet natural resources managers' needs across the Country.							

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan+ Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D

Note: Projected costs may not equal program change as these are full costs, which may include funds from other sources and (or) use averages.

Column A: The level of performance and costs expected in 2011 at the 2010 level plus funded fixed costs. Reflects the impact of prior year funding changes, management efficiencies, absorption of prior year fixed costs, and trend impacts, but does not reflect the proposed program change.

Column D: Outyear performance beyond 2011 addresses lagging performance — those changes occurring as a result of the program change (not total budget) requested in 2011. It does not include the impact of receiving the program change again in a subsequent outyear.

Program Overview

Biological Carbon Sequestration — Biological carbon sequestration refers to both natural and deliberate processes by which CO_2 is removed from the atmosphere and stored in vegetation, soils, and sediments. Biological carbon storage is susceptible to disturbances such as fire, disease, and changes in climate and land use. Deliberate biological sequestration can be accomplished through forest and soil conservation practices that enhance the storage of carbon (such as restoring and establishing new forests, wetlands, and grasslands) or reduce CO_2 emissions (such as reducing agricultural tillage and suppressing wildfires). The capacity of ecosystems to sequester additional carbon is uncertain, and the potential future vulnerability of biological carbon storage is difficult to predict. Decisions about biological carbon sequestration require careful consideration of priorities and tradeoffs among multiple resources. Assessment of biological carbon sequestration resources will require quantifying the factors that control potential sequestration, and providing information that can be used in complex resource management decisions and policies.

USGS scientific expertise is broadly interdisciplinary and uniquely qualified to assess the wide range of biological carbon sequestration resources. USGS scientists work at the multiple spatial scales necessary to link national assessments to regional and local needs. USGS historical datasets provide information needed to test and update time-dependent models that are used to estimate potential future carbon sequestration and greenhouse gas fluxes. The extensive land and resource management experience of the Interior provides an essential practical context for applying information about potential rates and capacities of carbon storage in ecosystems.

USGS is leading an Interior process to develop a methodology for a National Assessment of Biological Carbon Sequestration Resources. This activity, authorized by the Energy Independence and Security Act of 2007 (EISA), was initiated in 2009.

In 2010, stakeholder engagement continued, and an interagency science advisory panel composed of scientists from a range of Federal agencies will be convened to provide input to the methodology development team. At the close of 2010, the biological sequestration assessment methodology will near completion and technical issues and data gaps that could impact uncertainties and risks in the ability to assess biological carbon sequestration will be identified.

NCCWSC and the DOI Climate Science Centers — There is widespread recognition in the scientific and resource management communities that global climate change is already driving observable changes on the landscape, and will bring additional, large-scale changes in the coming decades. As a result, climate change and its impacts on natural and cultural resources are one of the top priorities for the USGS, and are a key concern for natural resource managers in the Department of the Interior and its external partners at Federal, State, regional and local levels. A vast amount of science and technical support is needed to tackle the complexities inherent in understanding and projecting climate change responses and potential management scenarios. The National Climate Change and Wildlife Science Center will provide full support to the Department of the Interior Regional Climate Science Centers, including establishing three DOI CSCs in 2010, two in 2011, and the remaining three in 2012.

In 2009, five regional and national stakeholder workshops were conducted to gather input on center structure, goals, operations, and science priorities; the workshops also served to build potential partnerships that will ultimately include scientific and decisionmaking oversight boards. Based on these workshops, a draft 5-year strategy was released to guide establishment and initial implementation. Over a dozen integrated research projects were funded that will lead to the development and testing of new downscaled models of climate effects on flora, fauna, and aquatic and terrestiral habitats. In addition, the NCCWSC initiated a Southeast Regional Assessment pilot project involving an extensive regional science and resource management partnership, and funding of a suite of integrated climate science studies and models. In 2010, throught the DOI CSCs, the effort will expand its capabilities to provide natural resource managers with the tools and information they need to develop and execute strategies for successfully adapting to and mitigating the impacts of climate change.

Science Applications & Decision Support — An example of interagency cooperation and decision support tool development for adapting to climate change was realized through research and applications carried out by researchers from the National Oceanic and Atmospheric Administration, the Bureau of Reclamation, USGS and resource managers (the U.S. Fish and Wildlife Service and native American Tribes) within Washington's Yakima River Basin (fisheries and water supply) and in Yellowstone National Park (Grizzly Bear habitat) during 2010. In the 2010-2011 academic year, the USGS is supporting a number of graduate students through the MIT/USGS Science Impact Collaborative working on climate change impacts and adaptation studies in Florida's Everglades National Park, in the Southwestern U.S., and internationally on the European continent training the next generation of applications scientists for the Nation. The USGS is also transitioning Earth-science research results to the operational missions of partnering agencies through the Science Applications and Decision Support element of the Global Change program's Climate Effects Network (CEN).

2011 Program Performance

Biological Carbon Sequestration Assessment — In 2010, biosequestration assessment activities will focus on testing and implementation of the methodology developed in 2009 and

2010, including use of the information gathered regarding technical issues and data gaps to inform the conduct of the assessment. Workshops will continue to be conducted to engage stakeholders, including regional workshops and at least one national policy and scenario workshop. In order to test and validate the methodology, the methodology will be prototyped in the Mississippi Delta region, which includes coastal estuary and wetlands environments, the Mississippi River alluvial plain, uplands, and urban areas and which exhibits high diversity of both land cover and land use.

DOI Climate Science Centers (DOI CSCs) — The DOI CSCs support the Department of the Interior's goal to improve the understanding of national ecosystems and resources through integrated interdisciplinary assessment. The goal of the DOI CSCs is to fulfill the congressional request to improve the science capacity for Federal agencies to respond to global warming and enhance science capacity in Federal land management and wildlife agencies. When fully implemented, eight DOI CSCs will be established to address climate-related scientific information needs of all Interior agencies that may be impacted by climate change, including land, water, marine, fish and wildlife, and cultural heritage resource management. These centers will be located in the following regions of the United States: Alaska, Northeast, Southeast, Southwest, North Central, South Central, Northwest, and Pacific Islands.

Results of scientific activities are communicated to customers in academia, resource management agencies, and the general public through models, decision support tools, project reports and peer-reviewed scientific papers, Websites, databases, and meetings with stakeholders. Metrics of program success in past years have included the number of products including models, reports and publications, number of people accessing Websites, and the frequency of meetings with stakeholders. These outputs support the intermediate outcome goal of ensuring availability of long-term environmental and natural resource information, data, tools, and systematic analyses needed by fish and wildlife, land and other natural resource managers for informed decisionmaking.

In 2011, funds from the NCCWSC, in support of the DOI CSCs will allow for expanded operations that include establishment of additional regional DOI CSCs, greatly increasing the capacity to fund the modeling, research, technical support, and outreach activities that are essential to accomplishing the core mission and the actions proposed above. In cooperation with its partners, the resources and science expertise of the DOI CSCs will:

- Use and create high resolution climate modeling information and derivative products to forecast ecological and population response at national, regional, and local levels;
- Integrate physical climate models with ecological, habitat, and population response models;
- Forecast fish and wildlife population and habitat changes in response to climate change.
- Assess the vulnerability and risk of species and habitats to climate change;
- Develop standardized approaches to modeling and monitoring techniques;
- Partner with and coordinate science capabilities across the region, including federal (e.g., climate science being conducted by the USGS, National Park Service, Fish and Wildlife Service, Bureau of Reclamation, Minerals and Management Service, Office of Surface Mining, National Oceanographic and Atmospheric Administration, and U.S. Department of Agriculture), university, state, tribal, local government, and NGO partners to provide climate change impact research, monitoring, forecasting, and decision support tool development for land, water, marine, fish and wildlife, and cultural heritage managers;

- Synthesize and integrate existing climate change impact data gathered by the Department and external partners, identify current gaps in knowledge, and develop management-relevant products that communicate climate change impacts on land, water, marine, fish and wildlife, and cultural heritage resources;
- Partner with resource managers to develop science-based adaptation strategies, including adaptive management and monitoring across the landscape; and
- Provide education opportunities for the public and stakeholders about the impacts climate change is having on DOI lands, adaptive management strategies, and sustainability and environmental leadership.

Science Applications & Decision Support — In 2011, the Science Applications and Decision Support element of the USGS Global Change program will continue its efforts to develop decision-support tools that enable resource managers and policymakers to cope with and adapt to a changing climate. Decision-support will be developed through new partnerships, enhancement of existing collaborations, and in training the next generation of applications scientists. Work in 2011 will also continue the development and expansion of collaborative efforts among the bureaus to encourage the interdisciplinary utilization of DOI CSCs science at the LCCs.

Program Performance Table

Target Codes:	SP = Strategic Plan Key measures	ARRA = Recovery Act measure
		UNK = Prior year data unavailable
	TBD = Targets have not yet been developed	BUR = Bureau specific measure
		NA = Long-term targets are inappropriate to determine at this time
Type Codes:	C = Cumulative Measure	A = Annual Measure F = Future Measure

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of surface area with temporal and spatial monitoring, research, and assessment/data coverage to meet land use planning and monitoring requirements (# of completed eco-region assessments out of a total of 84 eco-regions) **(Global Change)**	C	48%	61% (51/84)	71% (60/84)	86% (72/84)	86% (72/84)	100% (84/84)	Completed in 2010	--	NA
% of targeted geographic areas with temporal and spatial research, assessment and modeling of fish, wildlife and their habitats response to climate change to meet identified climate change adaptation planning and management needs (NCCWSC)	C	UNK	UNK	60% (3/5)	60% (6/10)	60% (6/10)	83% (25/30)	88% (35/40)	+75%	95% (38/40)

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Comments	This measure has been reworded and has a new baseline. A single year authorization in 2008 funded the inaugural workshop and five demonstration projects with 3/5 completed in 2008. Funding in 2009 allowed for three regional workshops, a final NCCWSC national workshop to finalize the CSC concept, two additional 2008 projects completed, and establishment of the national center for a total of 6 of 10 planned accomplishments (6/10). Three CSCs were established in 2010, twenty-two multi-year projects developed with stake-holder/ partner input to achieve almost full geographic coverage of the U.S. (25/30) with the denominator reflecting the anticipated additional five regional CSCs for full national coverage. The transition from regional CSC development to research activities continues in 2011 with establishment of two more regional CSCs, completion of the 2009 projects (22), 2010 projects (9), and two climate change science workshops (2) in 2010. The denominator (40) is estimated from anticipated funding levels and research outcomes of approximately five major partnership outcomes per each CSC. The 2012 38/40 reflects establishment of the final three CSC and completion of all ongoing projects. During development, establishment of the partnerships and collaboration to develop the geographic focus for project was the intermediate outcome. Out year performance will be based on research in the targeted geographic areas identified by regional management partners and conservation cooperatives and prioritized at the national level and estimated to be five major efforts per CSC.									
% of targeted land cover trends national assessment syntheses, research plans, or science strategies that are published **(Global Change)**	C	UNK	UNK	UNK	20% (1/5)	20% (1/5)	40% (2/5)	60% (3/5)	+20%	80% (4/5)
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100%	100%	100% (7/7)	100% (91/91)	100% (93/93)	100% (121/121)	100% (150/150)	0	100% (150/150)
Efficiency and Other Output Measures										
# of gigabytes collected annually **(BUR) (Global Change)**	A	2.8	2.8	2.8	2.8	2.9	2.8	2.8	0	2.8
# of gigabytes managed and distributed cumulatively **(BUR) (Global Change)**	C	13.8	16.6	19.4	22.2	22.3	25	27	+2	29
% of CEN established relative to current target **(Global Change)**	C	UNK	UNK	1% (0.2/20)	5% (1/20)	3% (0.6/20)	5% (1/20)	7.5% (1.5/ 20)	+2.5%	10% (2/20)
Comment	This measure has been reworded and has a new baseline. Optimal network includes planning, negotiated collaborations, development and execution of pilot programs, regional stakeholder workshops, topical science workshops, regional topical assessments and uncertainty analyses, determination of data gaps for optimized network, and filling of gaps in infrastructure or capacity. Support services include oversight, data management, quality control, synthesis, and decision support. The 2012 network represents Phase 1 of a multi-year plan and only completes a portion of the optimized national network (roughly 5-10%)									
# of Regional *DOI CSCs* established	C	UNK	UNK	UNK	UNK	UNK	3	6	+3	2

Climate Change Adaptation

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
# of systematic analyses and investigations completed **(BUR) (Global Change)**	A	UNK	UNK	7	91	93	121	150	+29	150
# of formal workshops or training provided to customers **(Global Change)**	A	UNK	UNK	3	15	15	30	40	+10	40

WaterSMART Program

	2009 Enacted	2009 Recovery Act	2010 Enacted	2011 DOI-wide Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
USGS WaterSMART Availability and Use Assessment							
Hydrologic Networks and Analysis ($000)	355	0	355	0	+6,400	6,755	+6,400
FTE	0	0	0	0	+5	5	+5
Groundwater Resources Program ($000)	1,594	0	1,594	0	+1,100	2,694	+1,100
FTE	0	0	0	0	0	0	0
Geographic Analysis and Monitoring ($000)	0	0	0	0	+500	500	+500
FTE	0	0	0	0	0	0	0
Biological Research and Monitoring ($000)	0	0	0	0	+500	500	+500
FTE	0	0	0	0	0	0	0
National Cooperative Geologic Mapping Program ($000)	0	0	0	0	+500	500	+500
FTE	0	0	0	0	0	0	0
Total Requirements	**1,949**	**0**	**1,949**	**0**	**+9,000**	**10,949**	**+9,000**
Total FTE	**0**	**0**	**0**	**0**	**+5**	**5**	**+5**

Summary of 2011 Program Changes for the USGS WaterSMART Availability and Use Assessment

Request Component	($000)	FTE
• Hydrologic Networks and Analysis	+6,400	+5
• Groundwater Resources Program	+1,100	0
• Geographic Analysis and Monitoring	+500	0
• Biological Research and Monitoring	+500	0
• National Cooperative Geologic Mapping Program	+500	0
TOTAL Program Changes	**+9,000**	**+5**

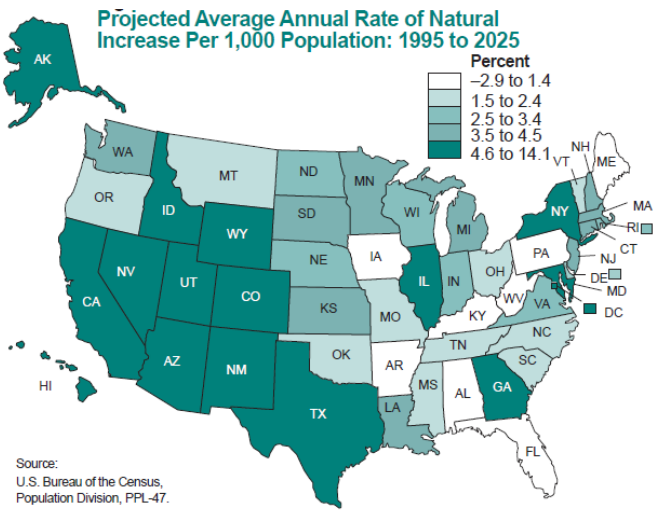
Justification of 2011 Program Changes

The 2011 budget request for the USGS WaterSMART Availability and Use Assessment initiative is $10,949,000 and 5 FTE, a net program change of +$9,000,000 and +5 FTE from the 2010 Enacted level.

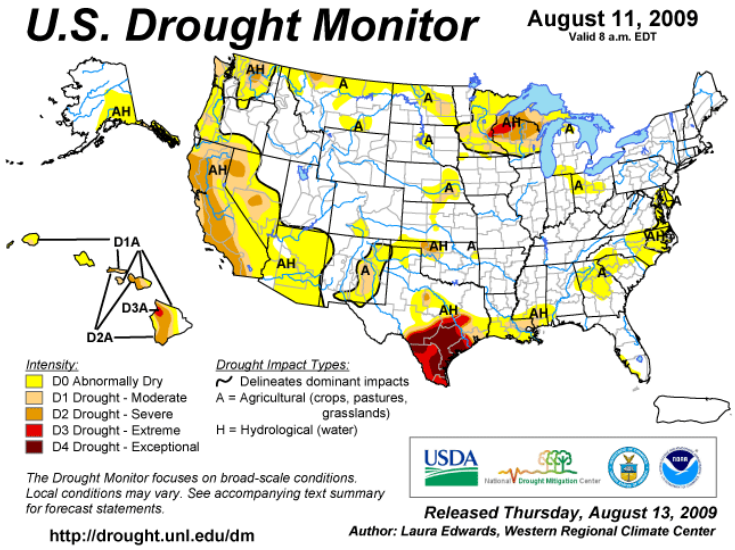
USGS WaterSMART Availability and Use Assessment Initiative (+$9,000,000 / +5 FTE)

21st Century Water Challenge—Water is essential to the economic security of individual communities across the United States and also to the economic vitality of our Nation as a whole. An assessment of the availability and use of water resources in the United States was last completed in 1978. Much has changed in the United States since 1978 and the time has come to establish a program that will address the need for a new and ongoing assessment of our water resources.

In its early history, U.S. water management focused on alleviating or controlling the impacts of floods and droughts. Investments in water infrastructure such as dams and canals provided safe, abundant, and inexpensive sources of water, aided flood management, and dramatically improved health and economic prosperity.



States with the greatest projected increase in population …



… are some of the same States facing drought conditions this year.

Today we are faced with a new set of water resource challenges. Aging infrastructure, rapid population growth, depletion of groundwater resources, impaired water quality associated with particular land uses and land covers, water needed for human and environmental uses, and climate variability and change all play a role in determining the amount of fresh water available at any given place and time. Water shortage and water-use conflict have become more commonplace in many areas of the United States – even in normal water years. As competition for water resources grows – for irrigation of crops, for growing cities and communities, for energy production, and for the environment – the need for information and tools to aid water resource managers also grows.

Response to the Challenge—The need to quantify, forecast, and secure freshwater to meet human, environmental and wildlife needs now and into the future has been well established. The National Research Council 2004 Report, "*Confronting the Nation's Water Problems: The Role of Research*" noted, "The strategic challenge for the future is to ensure adequate quantity and quality of water to meet human and ecological needs in the face of growing competition among domestic, industrial-commercial, agricultural, and environmental uses." The USGS Science Strategy, Circular 1309, *Facing Tomorrow's Challenges – U.S. Geological Survey Science in the Decade 2007-2017,* identifies the need to address this gap in understanding. It is one of six USGS science priorities contained in the Science Strategy.

The United States Congress and the President have also recognized the need for such an effort and have directed the Secretary of the Interior, through passage of the Omnibus Public Land Management Act of 2009 (P.L. 111-11), to establish a National Water Availability and Use Assessment Program. To demonstrate its commitment to further understanding of the Nation's freshwater resources, the USGS proposes its WaterSMART Availability and Use Assessment initiative as a means to address the requirements of the Secure Water subtitle of P.L. 111-11, signed by the President on March 30, 2009.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
% of the U.S. with completed, consistent water availability products that are used by partners for water resource management decisionmaking **(HNA)**	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	8% 180/2268	+8% 180/2268	16% 360/2268
Total Projected Cost ($000)	**0**	**0**	**0**	**0**	**0**	**$4,900**	**+$4,900**	**$9,800**
Comments	The addition of $4,900,000 will allow USGS to initiate an effort to provide nationwide water availability information. In the first year, critical information will be developed characterizing water flows, storage, use, water quality and ecological needs. This initiative will be targeted at completing a nationwide coverage of this information over the next decade. The denominator is established as follows: 378 (total number of HUC units) x 6 (the number of water availability indicators to be examined in each HUC: (1) surface water; (2) storage; (3) precipitation; (4) evapotranspiration; (5) ecological flows; (6) water use). The numerator is the total number of indicators addressed nationwide.							
X% of US with groundwater availability status and trends information to support resource management decisions **(GWRP)**	8% (3/40)	8% (3/40)	13% (5/40)	15% (6/40)	15% (6/40)	18% (7/40)	+3% (1/40)	20% (8/40)
Total projected cost ($000)	**1,050**	**1,125**	**2.050**	**2,700**	**2,700**	**3,185**	**+485**	**3,960**
Actual cost per water status product (whole dollars)	**350,000**	**375,000**	**410,000**	**450,000**	**450,000**	**455,000**	**+5,000**	**495,000**
Comments	Outyear performance beyond 2011 addresses lagging performance – those changes occurring as a result of the program change (not total budget) requested in 2011. It does not include the impact of receiving the program change again in a subsequent out-year.							

Program Overview

The United States needs a new assessment of water availability that links both water quality and quantity, tracks changing flow, use, and storage of water, and provides a foundation for developing models and predictive tools to guide water resources decisions. In 2007, the

National Science and Technology Council (NSTC) released a report entitled "*A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States*." The report stated, "The United States has a strong need for an ongoing census of water that describes the status of our Nation's water resource at any point in time and identifies trends over time." Knowing our Nation's water "assets" and rates of use on an ongoing basis is crucial to the wise management of this essential natural resource. In 2010, the USGS will release an implementation plan for the USGS strategic science direction focused on further understanding the Nation's water resources. The USGS WaterSMART Availability and Use Assessment is the foundation of this component of the USGS Science Strategy. The implementation plan will demonstrate how the USGS intends to implement and advance this effort. In this plan, the USGS will:

- Bring existing plans and legislative mandates together in one strategy;
- Integrate existing science efforts across the USGS and the Department of the Interior to focus resources on water availability questions; and
- Set forth a strategy to answer the questions:

  Does the Nation have an adequate quantity of water, with sufficient quality and timing-characteristics, to meet both human and ecological needs?

  Will this water be present to meet both existing and future needs?

The USGS goal for this effort is to place technical information and tools into the hands of stakeholders that will allow them to evaluate water availability for the questions that they are facing. The responsibility for management of water supplies rests at the State and local government level; however, knowledge and understanding of the hydrologic system is needed across State lines. Therefore, we need to provide seamless national information on water availability across political and jurisdictional boundaries. The USGS WaterSMART Availability and Use Assessment initiative will use and build on data and assessments accomplished through State and local initiatives, as well as information produced under programs such as the Cooperative Water Program. The Initiative will also use the strength of other Bureau programs such as:

- The National Water Quality Assessment Program to demonstrate the linkages between water quality and quantity and the degree of water quality impairment that limits water availability.
- Regional Groundwater Availability Studies to provide critical information including, recharge, yields, changes in storage, trends in groundwater indices, and groundwater-surface water interactions.
- The National Water Use Information Program to assess water withdrawals across the country.
- The National Cooperative Geologic Mapping Program for information on the geohydrologic framework of aquifer systems.

Products of the National Water Availability and Use Assessment will include:

A database containing key hydrologic information that addresses:

- Precipitation
- Evapotranspiration
- Water in storage in snowpack, ice fields, and large lakes
- Groundwater level indices
- Rates of groundwater recharge
- Changes in groundwater storage
- Stream and river run-off characteristics
- Stream and river baseflow characteristics
- Total water withdrawals by source
- Interbasin Transfers
- Consumptive Uses
- Return Flows
- Impaired surface and groundwater supplies used for existing demands;

A new program for assessing hydrologic flow needs for wildlife and habitat which will:

- Classify the streams across the Nation for their hydro-ecological type
- Systematically examine the ecological response to hydrologic alteration
- Develop flow alteration – ecological response relationships for each type of river or stream;

An application for delivering water availability information at scales that are necessary for stakeholders; and,

A series of studies focused on selected watersheds where significant competition for water resources currently exists, providing an opportunity for the USGS and stakeholders to work collaboratively to assess technical aspects of water availability.

Water Use Science. Humans have had a profound effect on the hydrologic cycle throughout development of the country. We change the run-off characteristics of the landscape, we affect how much water evaporates to the atmosphere, and we consume water and transfer it to other watersheds before it is returned to the environment. Understanding human use of water and how humans move water on the landscape is the science of water use. This initiative will allow the USGS to focus resources to better understand and quantify water use in the U.S. and to apply statistical rigor to the information that we use.

Water use will be estimated by 1) integrating National, State, and private databases of population, housing, climatological, agricultural, and economic information; 2) developing statistical relations between these data sets and metered withdrawal and delivery data for users across the region; and 3) using these relations to estimate water use (demand) across the region by small geographic areas. Many partners in all levels of government, industry, agriculture, water purveyors, and interest groups have much knowledge to share in this arena and the USGS will develop means to incorporate this valuable information.

Water Use Grants. Understanding that State water resource agencies are a cornerstone to the success of this effort, the USGS will implement a grant program to provide financial assistance to State water resource agencies for development of their water use datasets so that they may be easily integrated with Federal databases for the purposes of assessing water availability and

use. Grants will be provided, up to a maximum of $250,000 per State; four grants are planned for award in 2011.

Information Delivery. The delivery of water availability information must be timely, accessible, and served in a form that allows the information to be easily used by resource managers. It will be the goal of the USGS to provide this information at scales defined by the end user. The USGS will strive to provide much of this information in a "point and click" environment, where the user identifies the point in the watershed that they are interested in, has a basin-boundary automatically delineated, and then gains access to the relevant hydrologic information and trends within that boundary.

Geographically Focused Studies of Water Availability and Use. Throughout the United States there are areas where competition for water resources has reached a level of national attention and concern. Sometimes the competing interests are multiple human needs – needs for potable water, for irrigation, for energy, for industrial processes or for other uses. In other circumstances, the competition is between human and aquatic ecosystems needs. Through the USGS WaterSMART Availability and Use Assessment initiative, the USGS proposes a series of studies, focused on selected watersheds, where there is a desire on the part of watershed stakeholders to conduct a comprehensive technical assessment of water availability with the best available tools. These are critical to land and water resource managers to provide a comprehensive technical analysis of the factors affecting the availability of water. In 2011, the USGS proposes geographically focused studies of water availability and use in the Colorado River (CO, UT, WY, NV, NM, AZ, CA), Delaware River (NY, PA, NJ, DE), and Apalachicola, Chattahoochee, and Flint River Basins (AL, FL, GA). The USGS will work with watershed stakeholders and the various agencies involved in these geographic focus areas to scope and conduct these studies. Future geographic focus areas will be identified through the application of criteria being developed as part of the implementation plan for the USGS strategic science direction focused on our Nation's water resources.

Cooperation with other Agencies and Stakeholders. There are many opportunities to strengthen our understanding of water availability information through integration of national, regional and State datasets. The USGS will work with other Federal, State and regional agencies to make those linkages. Particular focus will be on agencies involved in environmental regulation, water allocation, water infrastructure, agriculture, energy, climatology and meteorology, as well as entities who maintain databases on commercial and industrial applications. The USGS will work closely with stakeholders to garner input during the development of the implementation plan. Through stakeholder input, the USGS will gain information useful to the assessment process, types of products most desirable for resource management agencies, criteria to use in the identification of geographic focus areas and ideas or strategies that may help increase public understanding of water availability as a societal issue.

State geologic surveys are an important partner in the USGS WaterSMART Availability and Use Assessment. They are key to understanding the subsurface framework of aquifer systems. Through new funding to the NCGMP, $250,000 will go to these State partners through a competitive grant process.

2011 Program Performance

- In 2011, the USGS WaterSMART Availability and Use Assessment initiative will launch an effort to produce a seamless coverage of hydrologic information across the entire Nation. This information includes all important aspects of the water cycle and the environmental and habitat requirements for water. It is envisioned that this coverage of hydrologic information will require a decade to complete for the Nation at the funding level proposed for 2011.
- In 2011, the USGS WaterSMART Availability and Use Assessment initiative will launch a research and assessment effort to characterize the flow needs for aquatic species and their habitat. In the first year, this effort will focus on classifying the streams across the Nation for their hydro-ecological type. In future years, the efforts begun in 2011 will expand to systematically examine the ecological response to hydrologic alteration and, later, develop flow alteration – ecological response relationships for each type of river or stream. It is envisioned that this research and assessment will require a decade to complete for the Nation at the funding level proposed for 2011.
- In 2011, the USGS WaterSMART Availability and Use Assessment initiative will expand the water use science program within the USGS. Initial efforts will concentrate on integrating national, State, and private databases of water withdrawal and use, return flows, population, housing, climatological, agricultural, and economic information. In future years, this information will be used to develop statistical relations between these data sets and metered withdrawal and delivery data for users across the region. Ultimately, these relations will be used to estimate water use (demand) across the region by small geographic areas. It is envisioned that comprehensive water use information will require five years to complete for the Nation at the funding level proposed for 2011.
- In 2011, the USGS WaterSMART Availability and Use Assessment initiative will begin three geographic focus area studies in the following basins: Colorado River, Delaware River, and Apalachicola, Chattahoochee, and Flint Rivers. The goal of these focus area studies will be to comprehensively examine all of the hydrologic and biologic aspects of water availability, as well as human water use, and to report on areas of significant competition over water resources and the factors that are influencing that competition. It is envisioned that each focus area study will require three years to complete, at which time an additional three studies in other areas will begin.
- In 2011, the USGS WaterSMART Availability and Use Assessment initiative will issue four grants to provide financial assistance to State water resource agencies to develop their water use datasets allowing for easy integration with Federal databases for the purposes of assessing water availability and use. Grants will be provided up to a maximum of $250,000 per State. One million dollars of grant funds will be available during the first year of this initiative.
- In 2011, the USGS WaterSMART Availability and Use Assessment will continue work on a national assessment of brackish and saline groundwater resources. The purpose of this study is to identify each brackish and saline aquifer in the Nation, describe the gaps in information that exist which prevent full characterization of the brackish and saline aquifers, and describe the current use of brackish and saline groundwater that is supplied by each aquifer that is identified. It is estimated that this study will take three years to complete.

Performance Overview Table

Target Codes:	SP = Strategic Plan Key measures	ARRA = Recovery Act measure
		UNK = Prior year data unavailable
	TBD = Targets have not yet been developed	BUR = Bureau specific measure
		NA = Long-term targets are inappropriate to determine at this time
Type Codes:	C = Cumulative Measure	A = Annual Measure F = Future Measure

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Enacted	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Efficiency and Other Output Measures										
% of the U.S. with completed, consistent water availability products that are used by partners for water resource management decision-making **(HNA)**	A	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	8% 180/2268	+8% 180/2268	16% 360/2268
Total Projected Cost ($000)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$4,900**	**+$4,900**	**$9,800**
Comments	The addition of $4,900,000 will allow USGS to initiate an effort to provide nationwide water availability information. In the first year, critical information will be developed characterizing water flows, storage, use, water quality and ecological needs. This initiative will be targeted at completing a nationwide coverage of this information over the next decade. The denominator is established as follows: 378 (total number of HUC units) x 6 (the number of water availability indicators to be examined in each HUC: (1) surface water; (2) storage; (3) precipitation; (4) evapotranspiration; (5) ecological flows; (6) water use). The numerator is the total number of indicators addressed nationwide.									
X% of US with groundwater availability status and trends information to support resource management decisions **(GWRP)**	A	UNK	8% (3/40)	8% (3/40)	13% (5/40)	13% (5/40)	15% (6/40)	18% (7/40)	+3%	20% (8/40)

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Enacted	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Total projected cost ($000)		**UNK**	**1,050**	**1,125**	**2.050**	**2,050**	**2,700**	**3,185**	**+485**	**3,960**
Actual/Projected cost per ground water status (whole dollars)		**UNK**	**350,000**	**375,000**	**410,000**	**410,000**	**450,000**	**455,000**	**+5,000**	**495,000**
% of the U.S. that is covered by at least one geologic map and is available to the public through the National Geologic Map Data Base **(NCGMP)**	C	44.13%	45.51%	47.71%	48.9%	48.9%	50%	51%	+1%	52%
# of knowledge products on the water availability and use provided to support management decisions **(WRD)**	A	0	0	0	0	0	0	0	0	0
Comment	Includes products produced for the Geographic Focus Area water availability studies in 2011. A determination of the number and location of focus area studies to begin in future years will be determined through development of the implementation plan. Three Geographic Focus Area studies will begin in 2011. This performance measure addresses **completed** products provided to support decisionmaking; therefore, improved performance will not accrue until after 2012.									

Treasured Landscapes (Chesapeake Bay Executive Order)

	2009 Actual	2009 Recovery Act	2010 Enacted	2011 DOI-wide Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Treasured Landscapes							
Base Funding	5,239	0	4,839	0	0	4,839	0
FTE	20	0	20	0	0	20	0
Global Change ($000)	0	0	0	0	+3,614	3,614	+3,614
FTE	0	0	0	0	+14	14	+14
Total Requirements ($000)	**5,239**	**0**	**4,839**	**0**	**+3,614**	**8,453**	**+3,614**
Total FTE	***20***	***0***	***20***	***0***	***+14***	***34***	***+14***

Summary of 2011 Program Changes for Treasured Landscapes

Request Component	($000)	FTE
Global Change	+3,614	+14
TOTAL Program Changes	**+3,614**	**+14**

Justification of 2011 Program Changes

The 2011 budget request for the Treasured Landscapes initiative is $8,453,000 and 34 FTE, a net program change of +$3,614,000 and +14 FTE from the 2010 Enacted level.

Chesapeake Bay Executive Order **(+$3,614,000 / +14 FTE)**

President Obama issued an Executive Order (E.O. 13508) on May 12, 2009 expressing the Federal government's lead in the restoration of the Chesapeake Bay. The E.O. directs the U.S. Environmental Protection Agency, and the Departments of the Interior, Commerce (NOAA), Agriculture, Defense, and Homeland Security to use their expertise and resources, working with partners, to protect and restore the Chesapeake Bay and its watershed. The Department of the Interior, through the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and U.S. Geological Survey (USGS), has been directed in the E.O. and the supporting restoration strategy to provide leadership, and contribute expertise and resources, for**:**

- Coordinating tools and science for decision making (USGS and NOAA lead)
- Assessing the impacts and adapting for climate change (USGS and NOAA lead);
- Expanding public access to the Bay and conserving landscapes (NPS lead); and
- Restoring habitats, fish, and wildlife (FWS and NOAA lead).

The proposed activities address the USGS Science Strategy themes (USGS Circular 1316) for (1) understanding ecosystems and predicting ecosystem change, and (2) climate variability and change. The proposed activities would include completing 3 systematic analysis and 2 workshops in 2011.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
				A		B=A+C	C	D
# of systematic analyses and investigations completed	5	5	5	5	5	8	+3	+1
Total Projected Cost ($000)	$168,600	$186,200	$157,080	$157,290	$157,290	$157,290	$0	$0
Projected Cost per systematic analysis (whole dollars)	$200,000	$200,000	$210,000	$210,000	$210,000	$210,000	$0	$0
# of formal workshops or training provided to customers	3	3	3	3	3	5	+2	+1
Total Projected Cost ($000)	$9,840	$9,040	$6,660	$7,740	$7,740	$7,740	$0	$0
Projected Cost per workshop (whole dollars)	$80,000	$80,000	$90,000	$90,000	$90,000	$90,000	$0	$0

Note: Projected costs may not equal program change as these are full costs, which may include funds from other sources and (or) use averages.
The level of performance and costs expected in the 2011 base reflects the impact of prior-year funding changes, management efficiencies, absorption of prior-year fixed costs, and trend impacts, but does not reflect the proposed program change.
Column D: Out-year performance beyond 2011 addresses lagging performance — those changes occurring as a result of the program change (not total budget) requested in 2011. It does not include the impact of receiving the program change again in a subsequent out-year.

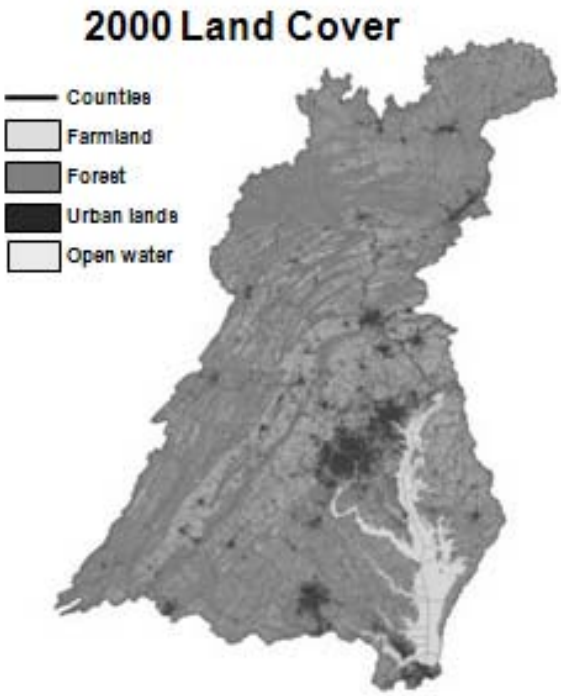
Program Overview

The USGS is working with federal agencies (NOAA, EPA, FWS, NPS, and USACE) to address the highest priorities of the E.O., with a focus on addressing the impacts of climate change and providing science to improve decision making. By increasing efforts to provide science to and engage state, local and private partners in a collective effort to improve water quality; conserve and restore habitats, fish, and wildlife; and plan for climate change in the Chesapeake Bay and watershed.

2010 Program Performance

Modeling Land Change in the Chesapeake Bay Watershed — The EPA lists 90 percent of the tidal waters of the Chesapeake Bay as “impaired” and has determined the total amount of nutrient and sediment load reductions required to improve the health of the Bay. Federal and state agencies are developing plans to implement a set of restoration actions needed to achieve the required load reductions by the year 2025. Because human activities on the landscape account for the majority of nutrient and sediment loads to the Bay and due to the unprecedented scale of the restoration effort, the USGS has developed a special Chesapeake Bay Land Change Model (CBLCM) to inform restoration management decisions.

The CBLCM is a geographic model that forecasts the amount and spatial patterns of urban growth into the future. The CBLCM converts County population forecasts into estimates of urban land demand and allocates demand onto the landscape accounting for both urban growth trends and the local suitability of land for development. The CBLCM is designed to simulate the effects of land use and conservation policies so that both can be explicitly included in state watershed implementation plans. Because wastewater is one of the major impacts of population growth on water quality, the EGSC has also developed a Sewer model, enabling the simulation of growth on municipal sewer and private septic systems. The USEPA intends to use the results from the CBLCM and Sewer model to consider the effects of population growth on the overall effectiveness of state watershed implementation plans.



In 2009 the CBLCM was web enabled and a Sewer model was prototyped. New and updated demographic, employment and land cover datasets were compiled and used to simulate alternative scenarios for infill and redevelopment across the Bay watershed. These models are being used to simulate the potential impacts of urban growth on farmland and forest resources, including habitat and Ecosystems.

2011 Program Performance

The USGS will conduct additional activities with federal partners to provide science to improve decision making and address the impacts of climate change. Additional USGS activities to provide science for improved decision making include:

- Support a decision-support specialist to work with USDA and EPA to prioritize and implement actions to improve water quality;
- Develop new applications in Chesapeake Online Adaptive Support Toolkit (COAST) to prioritize conservation of important ecological and cultural lands to support the NPS and conservation planning;
- Produce selected communications products to provide implications for targeting water quality and conservation actions, supporting USDA and EPA program implementation needs;
- Initiate sampling to determine the extent of emerging contaminants in water and fish tissue throughout the watershed and work with EPA and FWS to develop management solutions; and
- Work with EPA to design a data structure to improve sharing of science information.

In 2011, the USGS and NOAA will coordinate climate change science and adaptation activities with federal and state partners throughout the watershed, and implement climate change adaptation on federal lands and within federal agencies and programs. Additional USGS activities will include:

- Enhance models to better predict the impact of sea-level rise and storm surge on inundation of coastal areas of national parks, FWS refuges, and migratory bird wetlands;
- Improve the USGS Chesapeake Bay Land-Change Model, and use it to simulate the combined effects from alternative future climate and land use scenarios in support of FWS, NPS, and USDA's to development of adaptive strategies;
- Construct web-based decision-support applications in COAST to help DOI and other resource managers visualize future scenarios and prioritize areas for adaptation to climate and land-use change; and
- Design an integrated monitoring network, as part of the DOI Climate Effects Network, to document changing ecosystem conditions for priority species and their habitats, building from existing efforts including Interior networks (NPS vital signs program and the USGS land-change, streamflow, and water-quality monitoring) and on-going CBP partner efforts.

Increasing Resilience to Natural Hazards

Subactivity	2009 Enacted	2009 Recovery Act	2010 President's Budget	2011 Fixed Costs & Related Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Base funding	6,600	0	6,600	0	0	6,600	0
Biological Research and Monitoring ($000)	0	0	0	0	+ 200	200	+ 200
FTE	0	0	0	0	+1	1	1
Geographic Analysis and Monitoring ($000)	0	0	0	0	+ 250	250	+ 250
FTE	0	0	0	0	0	0	0
Earthquake Hazards Program ($000)	0	0	0	0	+ 1,800	1,800	+ 1,800
FTE	0	0	0	0	+ 3	3	3
Volcano Hazards Program ($000)	0	0	0	0	+ 1,500	1,500	+ 1,500
FTE	0	0	0	0	+ 2	2	2
Minerals Resources Program ($000)	0	0	0	0	+ 250	250	+ 250
FTE	0	0	0	0	0	0	0
Total Requirements ($000)	0	0	0	0	**+ 4,000**	**10,600**	**+ 4,000**
Total FTE	0	0	0	0	***+ 6***	***6***	***+ 6***

Summary of 2011 Program Changes for Increasing Resilience to Natural Hazards

Request Component	**($000)**	**FTE**
Increasing Resilience to Natural Hazards		
▪ Biological Research and Monitoring	+ 200	+1
▪ Geographic Analysis and Monitoring	+ 250	0
▪ Earthquake Hazards Program	+ 1,800	+ 3
▪ Volcano Hazards Program	+ 1,500	+ 2
▪ Minerals Resources Program	+ 250	0
TOTAL Program Changes	**+ 4,000**	**+ 6**

Justification of 2011 Program Changes

The 2011 budget request for Increasing Resilience to Natural Hazards is $10,600,000 and 6 FTE, a net program change of +$4,000,000 and +6 FTE from the 2010 Enacted level.

Increasing Resilience to Natural Hazards (+$4,000,000 / 6 FTE)

Expanding the Multi-Hazards Demonstration Project (+$1,700,000) The Multi-Hazards Demonstration Project (MHDP) in Southern California, will begin its fifth year in 2011, and this initiative proposes to build on the success of the Great Southern California ShakeOut by developing earthquake forecasting early warning capabilities and conducting impact analysis of environmental, human health and ecosystem responses to earthquakes and other hazards.

Earthquake Warning and Forecasting - The California portion of the Advanced National Seismic System (ANSS) for the last three years has been developing methodologies to estimate in a few seconds the probable magnitude of an earthquake. To be usable as an early warning system, data must be further analyzed to determine the probability of intense shaking that can be used to control a user's machinery (e.g., send elevator to nearest floor and open doors). We propose to work with our partners from the Great Southern California ShakeOut to develop a user-focused prototype system. This will demonstrate whether an operational system will be feasible in California.

USGS also proposes to expand the partnership with the Southern California Earthquake Center (SCEC), a university and government consortium with core funding jointly from USGS and the National Science Foundation, to prototype "operational earthquake forecasting", using California as the testbed. This project will seek knowledge about what information can be derived from observations before an earthquake and how this knowledge can be used to reduce seismic risk to communities, prepare them for earthquake disasters, and enhance their resiliency to seismic damage. This will include testing and validation of models and a focus on the San Andreas fault. Products will be forecasts of earthquake risk in California on timescales from hours to centuries. Primary partners are the California Emergency Management Agency and SCEC. USGS will work with the State of California to determine the best approach for distribution of these forecasts.

Economic, Environmental and Ecosystem Impact Analysis - The USGS proposes to expand research in disaster consequences. This will strengthen impact-focused research and integrate it with science focused on the hazards themselves to provide community leaders with a more complete picture of the consequences of disasters. Economic analyses of the post-disaster recovery process are in high demand from the user community. The USGS proposes to develop decision-support tools to better prepare for a large San Andreas earthquake as well as other disasters, supporting the winter storm and wildfire scenarios that are being developed in 2009 and 2010. Natural and anthropogenic disasters can produce large volumes of contaminated waters, soils, sediments, and other materials that pose potential threats to the environment and health of exposed humans and ecosystems. A formal environmental disaster response, research, and planning capability that will work with emergency responders will be funded as part of this effort.

Fires triggered by an earthquake is the single largest potential loss, and fire chiefs in southern California have asked for follow-on studies to better understand the risks and potential for mitigation. The USGS proposes to start a new effort to study fires triggered by earthquakes in both urban and wildland environments. The MHDP is already planning to investigate urban fuels and the role that landscaping can play in fires propagating through the wildland-urban interface. This information can be used to study the potential risks and propagation characteristics of fires triggered by earthquakes.

Pacific Northwest – Improving Hazard Products (+$900,000) The USGS hazard programs are integrated into regional hazard planning and mitigation activities to address multiple hazards in both Oregon and Washington. This initiative proposes improving risk assessments and monitoring capabilities in the Pacific Northwest to help decision makers and citizens prepare for and respond to natural hazards, building more resilient communities.

Improved forecasting for volcanic events – The USGS is implementing the National Volcano Early Warning System (NVEWS) in order to improve monitoring of volcanoes at levels prioritized to the threat level that they pose. USGS has determined that Cascade Range volcanoes are among the highest-threat volcanoes in the U.S., and most are under-monitored. This initiative proposes two activities to improve monitoring and forecasting capabilities: (1) work with the University of Washington to install co-located seismic and continuous GPS instruments to bring Oregon's very-high-threat Mount Hood Volcano to an optimal monitoring level, as defined by NVEWS, in 2012. This work will take advantage of the Cascade Range "backbone telemetry system" implemented with ARRA funds; and (2) work with state geological surveys in Washington and Oregon, FEMA, State, Tribal, and local emergency managers, and Federal land managers to develop multi-hazard risk and vulnerability assessments of select drainages at high and very high-threat volcanoes.

Improved earthquake situational awareness – The USGS has improved monitoring capabilities to provide rapid information products that deliver situational awareness to emergency responders following damaging earthquakes, delivering most earthquake locations and magnitudes within a minute or two. It sends maps showing peak recorded ground shaking a minute or two later, and calculates most ShakeMaps within about 5 to 7 minutes. However, in areas like the Pacific Northwest, where there are large variations in the characteristics of surface rocks, the number of operating strong motion seismometers are too few to allow details of the shaking pattern to be reliably calculated. To address the need for more instrumentation, the USGS developed NetQuakes, a new system designed for much quicker and less expensive installation than existing seismic stations, to supplement the existing Advanced National Seismic System (ANSS) backbone and regional network stations. In 2011, USGS would deploy 30 NetQuakes stations in Washington and Oregon, with a heavier concentration of instruments in the greater Puget Sound region. Installations will be done in cooperation with the University of Washington and will generally follow the guidance being developed by the Pacific Northwest Regional ANSS siting committee. The denser network of seismometers will take full advantage of new work to improve ShakeMaps undertaken in the region. For example, in Seattle, the USGS, the University of Washington, the State of Washington, FEMA, and the City of Seattle recently completed a test of improved USGS ShakeMap software that would use the new field instruments. The data generated by the state-of-the art network of NetQuakes systems will augment new seismic systems installed by the Geological Survey of Canada north of the border. Installation of seismic structural instrumentation will also take place on or near key pieces of public infrastructure such as highway bridges, hospitals, port and airport facilities, and

NetQuakes: An Overview

The USGS is working towards achieving a denser and more uniform seismograph spacing in selected urban areas to provide better measurements of ground motion during earthquakes. These measurements improve the ability to make rapid post-earthquake assessments of expected damage and contribute to the continuing development of engineering standards for construction.

USGS developed a new type of digital seismograph that communicates its data to the USGS via the Internet. These instruments connect to a local network using WiFi and existing Broadband connections to transmit data after an earthquake. These seismographs have been designed to be installed in private homes, businesses, public buildings and schools where there is an existing Broadband connection to the Internet.

possibly levees. Finally, the USGS will develop training for emergency managers to allow them to take full advantage of the products derived from using the data from the new instrumentation.

Building Resilience in Alaska Coastal Communities - (+$1,100,000) Expanding the multi-hazards demonstration project approach to Alaska would improve the ability of the USGS to support emergency planning and risk assessment of potential future hazards at and near the coastal population centers of Alaska. The communities that lie along Alaska's southern coast include a number of military facilities, port facilities, and all but one major airport. USGS would invest in earthquake, tsunami, and volcano science to support community planning. The output products from this activity would be used for planning and training for disaster response by the Department of the Interior as part of their Disaster Response Plan for Alaska in coordination with the State of Alaska, Department of Military and Veterans Affairs and the National Guard.

Assessing tsunami-generating earthquake sources -The 1964 magnitude-9.2 earthquake caused $1.9 billion of destruction to Anchorage in present-day dollars. The quake-generated tsunami that followed impacted communities that are today major ports of commerce, e.g., large cruise lines bring over $1.0 billion in economic value to Alaska annually. Valdez, which was completely destroyed by a tsunami following the 1964 earthquake, is the terminus of the Trans Alaska Pipeline System, which accounts for about 10% of domestic oil production.

The increase would be used to develop a catalog of onshore and offshore earthquake sources along the southern and southeastern Alaska margin and improve our understanding of specific earthquake hazards along that margin. This work would complement and support tsunami hazard assessments being undertaken by NOAA's National Tsunami Hazards Mitigation Program. Other partners and stakeholders would include the University of Alaska, U.S. Forest Service, and regional marine advisory councils.

High-threat volcano monitoring - Volcanic hazards are a major threat to public safety for southern coastal communities in Alaska. Of particular concern are the far-reaching impacts of explosive ash eruptions on aviation and communities and of lahars (mud flows) to infrastructures on the ground. Both problems were well-illustrated during the 2009 eruption of Redoubt Volcano. Ash clouds also disrupted domestic and international air travel during the 2006 Augustine eruption and the 2008 Okmok and Kasatochi eruptions.

One very high threat volcano in Alaska (NVEWS ranking) that will not be brought to an optimal monitoring level by the American Recovery and Reinvestment Act (ARRA) funds is Makushin Volcano, which is capable of explosive eruptions that threaten nearby Dutch Harbor/Unalaska. This community is the largest in the Aleutian Islands with a vital Alaska Native population and is responsible for a significant portion of the US seafood production. The USGS proposes to install additional seismic, GPS, and tilt sensors to bring the neighboring volcano to optimal monitoring level. In addition, USGS will undertake a multi-hazards assessment and planning effort with the community that will consider the combined threats of earthquakes, landslides, tsunamis, and explosive eruptions.

Improving USGS Disaster Response Capabilities (+$300,000) The USGS National Earthquake Information Center (NEIC) in Golden, Colorado, provides 24/7 detection and rapid location, analysis and dissemination of information for earthquakes world-wide. The USGS proposes to add a volcanic earthquake detection role to NEIC. Funds would be used to provide the necessary data transmission improvements for NEIC to import real-time seismic data from the five USGS volcano observatories.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
# of systematic analyses and investigations completed **(EHP)**	UNK	UNK	UNK	UNK	UNK	2	+2	0
Cumulative # of ANSS seismic monitoring stations **(EHP) (ARRA)**	UNK	UNK	UNK	UNK	UNK	50	+50	0
# of monitoring stations operated by VHP	UNK	UNK	UNK	UNK	UNK	15	+15	+17
% of very high threat volcanoes with at optimal level monitoring (X number of 18) **(VHP) (ARRA)**	UNK	UNK	UNK	UNK	UNK	2	+2	+2
# of systematic analyses and investigations completed **(GAM)**	UNK	UNK	UNK	UNK	UNK	2	+2	0

Program Overview

In 2007, the U.S. Geological Survey (USGS) launched the MHDP in southern California to strengthen USGS hazards science information to assist communities in becoming more resilient to natural disasters. Close cooperation with stakeholders has enabled the USGS to evaluate what science is most useful, how it can be applied, and how to encourage its use in making policy decisions. In just over two years, the project has led to substantial policy changes dealing with earthquake hazards through the widespread use of the ShakeOut scenario for a major earthquake on the Southern San Andreas Fault. Conducted in November 2008, the ShakeOut scenario became the basis for the largest public preparedness event in U.S. history. USGS scientists are now working with State and local interests in modeling the impacts of a major Pacific storm in a statewide multi-hazard scenario.

The multi-disciplinary activities piloted in this project now form a cornerstone for the “National Program to Assess Hazards, Risk, and Resiliency” goal in the USGS Science Strategy, *Facing Tomorrow's Challenges--U.S. Geological Survey Science in the Decade 2007-2017* (USGS Circular 1309). Congressional support has resulted in expanding the multi-hazard initiative activities to priority hazards in the Pacific Northwest and Central U.S. In 2011, the USGS proposes to strengthen its efforts with California communities, expand interdisciplinary science components in support of communities in the hazard-vulnerable Pacific Northwest, and initiate efforts for vulnerable Alaska coastal communities. In particular, this proposal takes advantage of the investments made in earthquake and volcano monitoring under the ARRA to significantly enhance the disaster response capabilities of the USGS, enabling our scientists to respond more quickly and thoroughly to volcanic eruptions and destructive earthquakes.

2011 Program Performance

This effort to increase communities' resilience to earthquake, volcanoes and related hazards will result in numerous products and studies as well as increased hazards monitoring capabilities. Some of these include:

- Forecasts of earthquake risks in California on timescales from hours to centuries;
- Decision-support tools to better prepare for the likelihood of a large San Andreas earthquake;
- A formal environmental disaster response, research, and planning capability to support emergency responders;
- A new effort to study fires triggered by earthquakes in both urban and wildland environments;
- Development of multi-hazard risk and vulnerability assessments at high and very high-threat volcanoes;
- Products used for planning and training for disaster response by the Department of the Interior as part of their Disaster Response Plan for Alaska;
- A catalog of onshore and offshore earthquake sources along the southern and southeastern Alaska margin, and improvement of our understanding of specific earthquake hazards along that margin; and
- Adding a volcanic earthquake detection role to NEIC by providing the necessary data transmission improvements to import real-time seismic data from the five USGS volcano observatories.

This effort also includes deploying 50 NetQuakes stations in Washington and Oregon and installing additional sensors to bring the Makushin Volcano, a very high threat volcano in Alaska, to an optimal level of monitoring. In addition, this effort will also add an additional 15 monitored sites for volcanic activity at Mount Hood and Mount Makushin.

Performance Overview Table

Target Codes:	SP = Strategic Plan Key measures	ARRA = Recovery Act measure
		UNK = Prior year data unavailable
	TBD = Targets have not yet been developed	BUR = Bureau specific measure
		NA = Long-term targets are inappropriate to determine at this time
Type Codes:	C = Cumulative Measure	A = Annual Measure F = Future Measure

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate or PART Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
% of very high threat volcanoes with at optimal level monitoring (X number of 18) **(VHP) (ARRA)**	C	UNK	UNK	22.2%	22.2%	22.2%	22.2%	33.3%	+11.1%	44.4%
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (EHP)**	A	2	152	132	140	146	157	159	+2	159
Cumulative number of ANSS seismic monitoring stations **(EHP) (ARRA)**	C	27 (cum. 723)	63 (cum. 786	19 (cum. 805)	17 (cum. 822)	64 (cum. 886)	406 (cum. 1292)	400 (cum.1692)	+400	1700
# of monitoring stations operated by VHP	C	694	714	734	737	743	743	758	+15	775
# of systematic analyses and investigations completed **(BUR) (GAM)**	A	79	67	93	65	90	65	92	+27	92

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Landsat Data Continuity Mission

	2009 Actual	2009 Recovery Act	2010 Enacted	2011 DOI-wide Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change from 2010 (+/-)
Land Remote Sensing ($000)	24,150	0	24,150	0	+13,350	37,500	+13,350
FTE	*15*	*0*	*15*	*0*	*+3*	*18*	*+3*
Total Requirements ($000)	**24,150**	**0**	**24,150**	**0**	**+13,350**	**37,500**	**+13,350**
Total FTE	***15***	***0***	***15***	***0***	***+3***	***18***	***+3***

Summary of 2011 Program Changes for Landsat Data Continuity Mission

Request Component	($000)	FTE
• Land Remote Sensing	+13,350	+3
TOTAL Program Changes	**+13,350**	**+3**

Justification of 2011 Program Changes

The 2011 budget request for Landsat Data Continuity Mission (LDCM) is $37,500,000 and 18 FTE, a net program change of +$13,350,000 and +3 FTE from the 2010 Enacted level.

Landsat Data Continuity Mission (LDCM) (+$13,350,000 / +3 FTE)

The USGS requests an increase of $13.35 million in 2011 to accommodate ground system requirements changes for LDCM associated with moving the Operational Land Imager (OLI) sensor to a free-flying satellite system and the addition of a Thermal Infrared Sensor (TIRS) on the spacecraft. The Mission Operations Element (MOE) and the Flight Operations Team (FOT) are related to the implementation of LDCM as a free-flyer. The requested increase of $13.35 million in 2011 accommodates the additional ground system requirements, including the addition of a thermal sensor, and maintains NASA's mission schedule for the LDCM launch in December 2012.

In 2011, additional ground system requirements include:

- **Mission Operations Element –** The MOE is responsible for the command and control of the spacecraft including the generation and management of the uplink command and software loads. The MOE is critical to sustaining the mission. With the decision to implement the LDCM as a free-flying spacecraft, the MOE became a requirement for the USGS LDCM Ground System.

- **Flight Operations Team –** The FOT is contractor staff with the responsibility for all command and control and telemetry operations with the satellite. In addition, the FOT provides off-line engineering support, anomaly response, performance analysis for the satellite, orbit determination and maintenance, and planning and scheduling of the system resources both on the spacecraft and on the ground. Prior to launch, this team is essential for learning the satellite and ground system functions and making sure all necessary command procedures and telemetry displays are generated. With the decision to implement the LDCM as a free-flying spacecraft, the FOT became a requirement for the USGS LDCM Ground System. The FOT will continue throughout the entire life of the mission.

- **Thermal Infrared Sensor –** Since the Landsat 4 mission launched in 1982, Landsat satellites have had a thermal capability that is useful to monitor wildfires, volcanic activity, and urban heat islands. The thermal capability is particularly useful in water management within agricultural regions using the measurement of evapotranspiration. Initially the LDCM did not have a thermal capability. In 2009, Congress provided direction and funding to the National Aeronautics and Space Administration (NASA) to add a TIRS to the LDCM mission. The inclusion of a second sensor will require the USGS to make necessary modifications to ingest and process a data stream from another sensor.

The requested increase of $13.35 million in 2011 provides for the additional technical support contractor staff to integrate and coordinate the MOE, FOT and TIRS into the planned development of the USGS LDCM Ground System. It also includes Federal employees necessary to provide long term oversight and technical engineering guidance for the additional developmental activities.

Program Performance Change

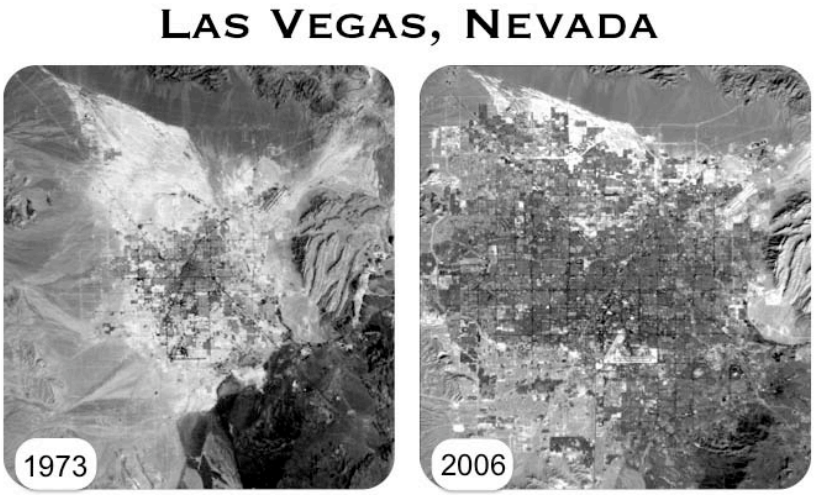
	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
% of critical milestones successfully reached to support the LDCM launch schedule	4% 1/23	35% 8/23	52% 12/23	70% 16/23	70% 16/23	83% 19/23	+13%	0
Comment	The current number of critical milestones to be reached in support of the LDCM launch schedule is 23.							

Note: Projected costs may not equal program change as these are full costs, which may include funds from other sources and (or) use averages.

Column A: The level of performance and costs expected in 2011 at the 2010 level plus funded fixed costs. Reflects the impact of prior year funding changes, management efficiencies, absorption of prior year fixed costs, and trend impacts, but does not reflect the proposed program change.

Column D: Outyear performance beyond 2011 addresses lagging performance—those changes occurring as a result of the program change (not total budget) requested in 2011. It does not include the impact of receiving the program change again in a subsequent out-year.

Program Overview



33 years of land change as seen from the Landsat series of satellites.

Landsat is a multispectral land remote sensing program dating back to 1972. The USGS has over 2.4 million Landsat images that are the only global, radiometrically accurate record of land surface change available over the last 37 years. LDCM, or Landsat 8, scheduled for launch in December 2012, is the eighth satellite in the Landsat Program. Presently, the USGS operates Landsat 5 and Landsat 7; two satellites that are well past their design lives. The launch of LDCM as soon as possible is necessary to avoid a Landsat data gap. Moreover, the USGS is charged to ensure Landsat data continuity by the Land Remote Sensing Policy Act of 1992 and the Presidential Decision Directive/NSTC-3 (1994) as amended on October 16, 2000.

Landsat 7 successfully launched in April 1999 and planning for the LDCM started in August 2000. It was initially conceived as a data buy, but this approach failed in September 2003 when NASA cancelled the solicitation because the sole bidder's proposal to the solicitation was judged to be unacceptable.

In August 2004, the Office of Science and Technology Policy (OSTP) decided to transfer future Landsat sensors to the planned NOAA NPOESS weather missions, in hope that putting the OLI on the NPOESS mission would avoid the cost of both a spacecraft and a launch vehicle. However, the total cost of installing the OLI onto the NPOESS spacecraft was later estimated to be greater than the cost of a separate spacecraft and launch vehicle due to the cost of technical solutions to deal with complex interactions between the OLI and the rest of the NPOESS spacecraft. This circumstance led to another OSTP decision in December 2005 to return LDCM to a NASA-built free-flying spacecraft, similar to all previous Landsat missions.

The USGS assumed additional responsibilities within the LDCM Ground System. The baseline LDCM Ground System budgetary requirements date back to decisions prior to December 2005. These had not been updated to reflect the changes in LDCM Ground System requirements associated with moving the OLI from NPOESS to a free-flyer. Originally, a new ground system was planned for LDCM. In late 2008, the USGS determined that there was neither enough time in the schedule nor budget to build an entirely new ground system for LDCM. The USGS looked for possible alternatives and decided to use portions of the current Landsat 7 ground system combined with the development of elements unique to the new mission. This approach yields an overall total in savings of $32.5 million through 2013.

2011 Program Performance

In 2010, the USGS will:

- Complete the Critical Design Reviews for the Ground Network Element, the Data Processing & Archive System (DPAS), and the LDCM Ground System;
- Deliver the Collection Activity Planning Element (CAPE) software release, which includes the basic planning and scheduling capabilities for the LDCM sensors; and,
- Participate in and complete two of the Ground Readiness Tests (GRTs) (series of seven).

In 2011, the USGS plans to:

- Deliver the final software releases of the CAPE, which implement the remaining requirements needed to support the LDCM launch;
- Deliver two DPAS software releases that will provide the capabilities to ingest mission data files; and,
- Participate in and complete an additional three Ground Readiness Tests.

Coastal and Marine Spatial Planning

	2009 Enacted	2009 Recovery Act	2010 President's Budget	2011 DOI-wide Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Coastal and Marine Geology Program ($000)	0	0	0	0	+ 4,000	4,000	+ 4,000
FTE	0	0	0	0	+8	8	+8
Total Requirements ($000)	0	0	0	0	**+ 4,000**	**4,000**	**+ 4,000**
Total FTE	0	0	0	0	***+ 8***	***8***	***+ 8***

Summary of 2011 Program Changes for Coastal and Marine Spatial Planning

Request Component	($000)	FTE
▪ Coastal and Marine Geology Program	+ 4,000	+8
TOTAL Program Changes	**+ 4,000**	**+ 8**

Justification of 2011 Program Changes

The 2011 budget request for Coastal and Marine Spatial Planning is $4,000,000 and 8 FTE, a program change of +$4,000,000 and +8 FTE from the 2010 Enacted level.

Coastal and Marine Spatial Planning **(+$4,000,000 / 8 FTE)**

The funds provided through this increase would support engagement of USGS and other DOI bureaus in the incorporation of Coastal and Marine Spatial Planning (CMSP) activities within the ocean governance structure and the development of a Strategic Action Plan (SAP) for CMSP implementation.

The CMSP implementation guidance recognizes the need to prioritize efforts that will vary regionally. The funds provided will enable USGS and DOI bureau engagement in planning and implementation at both national and regional levels ensuring regional responsiveness and national consistency in objectives, performance measures, guidance and standards relevant to a national information management system. While supporting overarching CMSP implementation, including strategic planning, national workshops, and CMSP simulation exercise; the funding provided will largely support USGS and DOI engagement in development of a National Information Management System (NIMS) as a critical and enabling element of CMSP implementation. Working with interagency partners, and building on critical information expertise and assets maintained by DOI bureaus and partners, the USGS will provide essential knowledge and systems for collaborative development of the NIMS and CMSP portal(s); further the development and adoption of data standards consistent with government-wide information quality standards; and identify and begin development of any new tools or models needed for CMSP in all regions. The results of this collaborative effort will include a prototype CMSP portal and strategic guidance for continued NIMS development within the SAP.

While the specific development path to be followed will evolve in response to analyses of National and Regional requirement and the collaborative planning process; the USGS will provide support for several critical elements reflecting established DOI leadership in information provision and management. Areas of potential emphasis include:

- Increasing the availability of relevant and appropriate geospatial data; including coastal and marine geospatial data, imagery, and interpretive maps. This effort will build on partnerships established through the FGDC structure and advance the objectives of the Ocean and Coastal Mapping Integration Act led by the NSTC Interagency Subcommittee on Coastal and Ocean Mapping. Tools, expertise, and systems maintained through the FGDC Geospatial One-Stop program, the National Map, and other USGS national geospatial data systems will be integrated with the MMS/NOAA Multipurpose Marine Cadastre; the NOAA Digital Coast; and other DOI and federal geospatial information systems to meet the requirements of the NIMS.

- Enhancing the availability and ability to integrate water quantity and quality information, building on established USGS hydrologic information systems (NWIS) and the interagency (USGS, NOAA, EPA) Water Quality Exchange to ensure that NIMS information reflects the connectivity of hydrologic systems across the coastal boundary and into coastal receiving waters.

- Developing standards and protocols to provide integrated biological information, building on the expertise resident within the National Biological Information Infrastructure and ensuring consistency with other national information assets including DOI and NOAA fisheries and biological resource data systems; and

- Supporting development of widely available tools to integrate model output and observational data, building on existing partnership between the USGS, NOAA and NSF.

- USGS will coordinate with MMS and NOAA to collaborate on data collection, modeling, data standards, information access systems, and other foundational elements to develop an integrated ocean and coastal mapping program. This will begin with a pilot study, which may be undertaken for the Gulf Coast.

The specifics of these efforts, and the distribution of resources both within USGS and to DOI and other partner agencies, will be guided by an interagency collaborative process ensuring coordinated development. That development will leverage with and ensure consistency with existing federal programs. It is expected that regional and national priorities will provide guidance supporting implementation that intersects with DOI priorities with respect to offshore renewable energy development and resource management and supports the priorities of the Ocean Research Priorities Plan.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
# of systematic analyses and investigations completed for Coastal and Marine Spatial Planning (C&M)	UNK	UNK	UNK	UNK	UNK	10	+10	15

Program Overview

DOI, with substantial coastal and ocean resource management responsibilities, has a critical role in implementation of the Administration's National Ocean Policy. The USGS, as the science and information bureau for DOI, will actively engage with other DOI bureaus and federal agencies in implementation of the soon-to-be finalized "Framework for Effective Coastal and Marine Spatial Planning". This framework for CMSP includes implementation guidance for phased and collaborative development, including Federal, State, tribal, and other partners; to develop capacity, build on existing efforts, and leverage and gain efficiencies from lessons learned.

2011 Program Performance

During 2011, USGS projects will prepare scientific reports and present papers on information infrastructure and data resources that supports the National Ocean Plan (NOP) and CMSP. Talks will be presented at scientific meetings and supporting papers will be submitted to peer-reviewed journals and/or trade publications such as *Sea Technology* which reach key ocean and coastal audiences.

Performance Overview Table

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed for Coastal and Marine Spatial Planning (C&M)	A	UNK	UNK	UNK	UNK	UNK	UNK	10	+10	15

Budget at a Glance
(Dollars in Thousands)

	2009 Actual	2009 Recovery Act a/	2010 Enacted	DOI-Wide Changes b/ c/	Program Changes	2011 Request
Appropriation: Surveys, Investigations and Research						
Geographic Research, Investigations, & Remote Sensing						
Land Remote Sensing	**61,718**	**0**	**63,707**	**-1,195**	**13,350**	**75,862**
Completion of Landsat Data Continuity Mission Ground System	[24,200]		[24,200]		13,350	[37,550]
Geographic Analysis and Monitoring	**10,598**	**0**	**11,135**	**-192**	**750**	**11,693**
Establish WaterSMART Program	NA		NA		500	[500]
Provide Funding for Increasing Resilience to Natural Hazards	NA		NA		250	[250]
National Geospatial Program			**70,748**	**-1,361**	**-3,500**	**65,887**
Reduce Funding for the National Map Partnerships			[13,900]		-3,500	[10,400]
Total, GRIRS	**72,316**	**0**	**145,590**	**-2,748**	**10,600**	**153,442**
Geologic Hazards, Resources, & Processes						
Geologic Hazard Assessments	**90,585**	**44,655**	**92,763**	**-1,643**	**1,800**	**92,920**
Provide Funding for Increasing Resilience to Natural Hazards (EHP)	NA		NA		1,800	[1,800]
Provide Funding for Increasing Resilience to Natural Hazards (VHP)	NA		NA		1,500	[1,500]
Remove Congressional Add-on for LIDAR & High Risk Seismology Activities (EHP)	NA		[1,000]		-1,000	[0]
Eliminate Earmark for Coop Partnership with University of HI - Manoa & USGS HVO (VHP)	NA		[250]		-250	[0]
Remove Congressional Add-on for General Increase for Global Seismographic Network (GSN)	NA		[250]		-250	[0]
Geologic Landscape & Coastal Assessments	**72,381**	**0**	**74,351**	**-1,266**	**4,500**	**77,585**
Establish WaterSMART Program (NGCMP)	NA		NA		500	[500]
Provide Funding for Coastal and Marine Spatial Planning (CMG)	NA		NA		4,000	[4,000]
Geologic Resource Assessments	**79,176**	**0**	**82,017**	**-1,289**	**2,600**	**83,328**
Provide Funding for Increasing Resilience to Natural Hazards (MRP)	NA		NA		250	[250]
Continue Funding for New Energy Frontiers Initiative - Wind (ERP)	NA		NA		3,000	[3,000]
Eliminate Earmark for Nye County, Nevada Mineral Resource Assessment (MRP)	[650]		[650]		-650	[0]
Total, GHRP	**242,142**	**44,655**	**249,131**	**-4,198**	**8,900**	**253,833**

Budget at a Glance (Continued)
(Dollars in Thousands)

	2009 Actual	2009 Recovery Act a/	2010 Enacted	DOI-Wide Changes b/ c/	Program Changes	2011 Request
Water Resources Investigations						
Hydrologic Monitoring, Assessments & Research	**150,786**	**14,625**	**160,246**	**-4,590**	**3,074**	**158,730**
Establish WaterSMART Program (GWRP)	[1,594]		[1,594]		1,100	[2,694]
Establish WaterSMART Program (HNA)	[355]		[355]		6,400	[6,755]
Eliminate Earmark for San Diego, CA Aquifer Mapping (GWRP)	[900]		[900]		-900	[0]
Eliminate Earmark for Arkansas Sparta Aquifer Recovery (GWRP)	NA		[300]		-300	[0]
Eliminate Earmark for McHenry Cnty IL Groundwater & Stormwater Protection (GWRP)	NA		[280]		-280	[0]
Eliminate Earmark for Hood Canal Dissolved Oxygen Study (HRD)	[270]		[200]		-200	[0]
Eliminate Earmark for Long-Term Estuary Group (HRD)	[400]		[400]		-400	[0]
Eliminate Earmark for US-Mexico Transboundary Aquifer (HRD)	[500]		[1,000]		-1,000	[0]
Reduce Funding for Lake Champlain Basin Toxic Materials (HNA)	[497]		[500]		-346	[154]
Eliminate Earmark for Monitoring of Water Resources in Hawaii (HNA)	[500]		[500]		-500	[0]
Eliminate Earmark for Assessment of MD Coastal & Piedmont Aquifer System (HNA)	NA		[500]		-500	[0]
Cooperative Water Program	**64,078**	**0**	**65,561**	**-1,963**	**0**	**63,598**
Water Resources Research Act Program	**6,500**	**0**	**6,500**	**-1**	**0**	**6,499**
Total, WRI	**221,364**	**14,625**	**232,307**	**-6,554**	**3,074**	**228,827**
Biological Research						
Biological Research and Monitoring	**146,416**	**0**	**160,685**	**-3,014**	**1,780**	**159,451**
Establish WaterSMART Program	NA		NA		500	[500]
Provide Funding for Increasing Resilience to Natural Hazards	NA		NA		200	[200]
Provide Funding for Increasing Science Support to FWS/NPS/BLM	NA		NA		4,000	[4,000]
Eliminate Earmark for San Francisco Salt Ponds Restoration Efforts	[500]		[1,000]		-1,000	[0]
Eliminate Earmark for Conte Anadromous Fish Research Lab	NA		[220]		-220	[0]
Eliminate Earmark for Invasive Species Protocols in Columbia River Basin	NA		[350]		-350	[0]
Eliminate Congressional Add-on for General Genetics & Genomic Research	NA		[750]		-750	[0]
Eliminate Congressional Add-on for Tropical Ecosystems & Watershed Health Research	NA		[600]		-600	[0]
Biological Information Management & Delivery	**21,965**	**0**	**24,946**	**-568**	**-1,628**	**22,750**
Reduce Congressional Add-on for Nat'l Network of State Conserv. Data Agencies	NA		[2,000]		-1,428	[572]
Reduce Congressional Add-on for National Biological Information Infrastructure	NA		[750]		-200	[550]
Cooperative Research Units	**16,949**	**0**	**19,313**	**-170**	**0**	**19,143**
Total, BR	**185,330**	**0**	**204,944**	**-3,752**	**152**	**201,344**

Budget at a Glance (Continued)
(Dollars in Thousands)

	2009 Actual	2009 Recovery Act a/	2010 Enacted	DOI-Wide Changes b/ c/	Program Changes	2011 Request
Enterprise Information						
Enterprise Information Security and Technology	**25,176**	**0**	**26,263**	**-286**	**-2,500**	**23,477**
Reduce Funding for IT Efficiency Gains	[2,500]		[2,500]		-2,500	[0]
Enterprise Information Resources	**17,478**	**0**	**19,706**	**-182**	**-1,500**	**18,024**
Reduce Funding for IT Efficiency Gains	[1,500]		[1,500]		-1,500	[0]
National Geospatial Program	**69,816**	**14,625**				
Total, EI	**112,470**	**14,625**	**45,969**	**-468**	**-4,000**	**41,501**
Global Change						
	40,628	**0**	**58,177**	**-692**	**14,614**	**72,099**
Increase Funding for Climate Impacts - Science Applications/Decision Support	[1,500]		[1,500]		1,000	[2,500]
Increase Funding for Climate Impacts - DOI Climate Science Centers	[10,000]		[15,000]		8,000	[23,000]
Increase Funding for Climate Impacts - Biological Carbon Sequestration Assessment	[1,500]		[5,048]		2,000	[7,048]
Increase Funding for Chesapeake Bay Executive Order	NA		NA		3,614	[3,614]
Total, GC	**40,628**	**0**	**58,177**	**-692**	**14,614**	**72,099**

Budget at a Glance (Continued)
(Dollars in Thousands)

	2009 Actual	2009 Recovery Act a/	2010 Enacted	DOI-Wide Changes b/ c/	Program Changes	2011 Request
Science Support						
	67,430	3,788	69,225	8,159	0	77,384
Total, SS	67,430	3,788	69,225	8,159	0	77,384
Facilities						
Rental Payments and Operations & Maintenance	94,802	0	99,076	-1,454	0	97,622
Deferred Maintenance & Capital Improvement	7,321	62,307	7,321	-2,514	0	4,807
Construction				2,500	0	2,500
Total, Fac	102,123	62,307	106,397	-1,468	0	104,929
TOTAL, SIR	1,043,803	140,000	1,111,740	-11,721	33,340	1,133,359

a/ A new treasury account was created for the Recovery Act appropriation; direct allocations to programs were not made.

b/ Fixed costs changes for this account total $13,528 of which $13,528 is absorbed.

c/ The DOI-Wide Changes column includes three components: (1) Related Changes - Budget Restructures that net to zero; (2) DOI-Wide Management Efficiencies - savings that result in reductions totaling -$11.648 million in reductions; and (3) DOI Working Capital Fund adjustments - a net reduction of -$0.073 million). For additional information related to these components at the budget structure level of detail, see the General Statement and Section G ("Details for DOI-Wide Changes" table).

Program Increases

Component	2011 Program Change ($000)	Page Reference
New Energy Frontier	+3,000	E-1
Climate Change Adaptation	+11,000	E-5
WaterSMART Program	+9,000	E-17
Treasured Landscapes (Chesapeake Bay)	+3,614	E-27
Increasing Resilience to Natural Hazards	+4,000	E-31
Landsat Data Continuity Mission	+13,350	E-39
Coastal and Marine Spatial Planning, PEO on Oceans	+4,000	E-43
FWS/NPS/BLM Science Support	+4,000	L-6
Interagency Great Lakes Initiative	[+$10,300]	F-13
Total	**51,964**	

Secretarial Initiatives

New Energy Frontier (+$3.0 million/5 FTE)

The U.S. Geological Survey (USGS) will assess the impacts to wildlife associated with new technologies used for the development of wind energy and work closely with Interior agencies (e.g., U.S. Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), National Park Service (NPS), and the Minerals Management Service (MMS)) to provide the scientific information they need to make informed decisions concerning the permitting, implementation and operation of wind facilities on public lands.

USGS research, modeling, and monitoring will assess the ecological impacts to fish and wildlife associated with the widespread development of wind energy. Ecological and geographic studies will examine impacts to fish and wildlife from direct strikes, habitat fragmentation, and construction and maintenance of infrastructure. The infrastructure needed for energy capture and transmission would include wind turbines and generating facilities as well as towers, cables, and roads, sea bed corridors, and boat traffic. USGS science will be directed towards studying causes and identifying solutions that will minimize risk to fish and wildlife and assess the ecological impacts of projected large-scale development of wind-farms in the Great Plains and offshore in the Atlantic. In addition, USGS science will provide technical support, establish a comprehensive data management structure, facilitate collaboration, and ensure long-term viability of information products that contribute to the Nation's understanding of the management and effects of wind energy. In 2011, USGS efforts will begin in the Great Plains and offshore Cape Cod region, and will work toward developing an assessment methodology that can be applied nationwide. These proposed efforts will build on work that is being proposed in 2010.

The research, modeling, and monitoring activities associated with this effort will be conducted by several USGS programs including Biological Research and Monitoring, Geographic Analysis and Monitoring, and the Coastal and Marine Geology program.

Climate Change Adaptation (+$11.0 million/12 FTE)

Developing the next generation of scientists is a priority for the USGS. Utilizing existing programs such as the Cooperative Fish and Wildlife program, EDMAP in National Cooperative Geological Mapping (NCGMP), and grants to universities, the USGS is providing the opportunities for college students to work on science projects important to the mission of the Department of the Interior. The USGS will involve students in this initiative through these programs.

Biological Carbon Sequestration Assessment (+$2,000,000) — An increase of $2.0 million in the Climate initiative is requested for the USGS to continue the implementation of the methodology for the national assessment of biological carbon sequestration developed in previous years. These activities were authorized in the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), which calls for comprehensive assessment of geologic and biologic carbon sequestration to enable decisionmakers to evaluate the full range of sequestration options. The 2010 budget for sequestration activities is $10.0 million, which includes $5.0 million for geologic carbon sequestration assessment and $5.0 million for biological carbon sequestration assessment. The 2011 increase of $2.0 million specifically supplements the $5.0 million received in 2010 for ongoing and increased activities in biological carbon sequestration.

DOI Climate Science Centers (+$8,000,000) — Management decisions made in response to climate change impacts must be informed by science and require that scientists work in tandem with those managers who are confronting climate change impacts and evaluating options to respond to such impacts. Pursuant to P.L. 110-161, the USGS began the development of the National Climate Change and Wildlife Science Center (NCCWSC). The NCCWSC is being expanded by the addition of regional science centers with a primary focus on providing climate change impact data and analysis geared to the needs of fish and wildlife managers as they develop adaptation strategies in response to climate change. These centers are being developed in close collaboration with Interior agencies and other Federal, State, university, and non-governmental partners.

Science Applications & Decision Support (+$1,000,000) — In 2011, the Science Applications and Decision Support element of the USGS Global Change program will continue its efforts to develop decision-support tools that enable resource managers and policymakers to cope with and adapt to a changing climate. Collaborations with a number of academic institutions including Cornell University, Colorado State University, the Massachusetts Institute of Technology (MIT), and Montana State University have been established, spanning the fields of social science, natural resources, artificial intelligence, statistics, and earth sciences. Decision-support will be developed through new partnerships, enhancement of existing collaborations, and in training the next generation of applications scientists.

WaterSMART Program (+$9.0 million/5 FTE)

21st Century Water Challenge—Water is essential to the economic security of individual communities across the United States and also to the economic vitality of our Nation as a whole. An assessment of the availability and use of water resources in the United States was

last completed in 1978. Much has changed in the U.S. since 1978 and the time has come to establish a program that will address the need for a new and ongoing assessment of our water resources.

In its early history, U.S. water management focused on alleviating or controlling the impacts of floods and droughts. Investments in water infrastructure such as dams and canals provided safe, abundant, and inexpensive sources of water, aided flood management, and dramatically improved health and economic prosperity. The U.S. water resources, infrastructure, and technologies became the envy of the world.

Today we are faced with a new set of water resource challenges. Aging infrastructure, rapid population growth, depletion of groundwater resources, impaired water quality associated with particular land uses and land covers, water needed for human and environmental uses, and climate variability and change all play a role in determining the amount of fresh water available at any given place and time. Water shortage and water-use conflict have become more commonplace in many areas of the U.S. – even in normal water years. As competition for water resources grows – for irrigation of crops, for growing cities and communities, for energy production, and for the environment – the need for information and tools to aid water resource managers also grows.

Treasured Landscapes (+$3.6 million/14 FTE)

President Obama issued an Executive Order (E.O.) on May 12, 2009 to have the Federal government lead the restoration of the Chesapeake Bay, the Nation's largest estuary. The E.O. directs the U.S. Environmental Protection Agency (EPA), and the Departments of the Interior, Commerce (NOAA), Agriculture, Defense, and Homeland Security to use their expertise and resources, working with partners, to protect and restore the Chesapeake Bay and its watershed. The Department of the Interior, through the FWS, NPS, and the USGS, has been directed in the E.O. and the supporting restoration strategy to provide leadership, and contribute expertise and resources, for**:**

- Coordinating tools and science for decision-making (USGS and NOAA lead)
- Assessing the impacts and adapting for climate change (USGS and NOAA lead);
- Expanding public access to the Bay and conserving landscapes (NPS lead); and
- Restoring habitats, fish, and wildlife (FWS and NOAA lead).

<u>Mission Increases</u>

Increasing Resilience to Natural Hazards (+$4.0 million/6 FTE)

Expanding the Multi-Hazards Demonstration Project (+$1,700,000) — The Multi-Hazards Demonstration Project (MHDP) in Southern California, will begin its fifth year in 2011, and this initiative proposes to build on the success of the Great Southern California ShakeOut by developing earthquake forecasting early warning capabilities and conducting impact analysis of environmental, human health and ecosystem responses to earthquakes and other hazards.

Pacific Northwest – Improving Hazard Products (+$900,000) — The USGS hazard programs are heavily integrated into regional hazard planning and mitigation activities to address multiple hazards in both Oregon and Washington. This initiative proposes improving risk assessments and monitoring capabilities in the Pacific Northwest to help decision makers and citizens prepare for and respond to natural hazards, building more resilient communities.

Program Increases

Building Resilience in Alaska Coastal Communities (+$1,100,000) — Expanding the multi-hazards demonstration project approach to Alaska would improve the ability of the USGS to support emergency planning and risk assessment of potential future hazards at and near the coastal population centers of Alaska. The communities that lie along Alaska's southern coast include a number of military facilities, port facilities, and all but one major airport. The USGS would invest in earthquake, tsunami, and volcano science to support community planning. The output products from this activity would be used for planning and training for disaster response by the Department of the Interior as part of their Disaster Response Plan for Alaska in coordination with the State of Alaska, Department of Military and Veterans Affairs and the National Guard.

Improving USGS Disaster Response Capabilities (+$300,000) — The USGS National Earthquake Information Center (NEIC) in Golden, Colorado, provides 24/7 detection and rapid location, analysis and dissemination of information for earthquakes world-wide. The USGS proposes to add a volcanic earthquake detection role to NEIC. Funds would be used to provide the necessary data transmission improvements for NEIC to import real-time seismic data from the five USGS volcano observatories, as well as provide two FTE at NEIC to handle the added workload. Volcanoes usually experience increased micro-seismicity well in advance of an eruption. These are much too small to cause damage or even to be felt, but they provide a critical early warning to give observatories and affected communities time to plan and prepare for an eruption. Adding volcano monitoring to NEIC would provide an important backup to observatory-based monitoring, through more frequent checking of data and the setting of automated alarm systems at a more sensitive threshold (because of a higher tolerance for false alarms), thereby ensuring that signs of volcano unrest are detected as early as possible. Once such unrest is detected, the responsible observatory would take over 24/7 operations, as is the practice now. NEIC would also provide an initial point of contact for federal agencies such as the Air Force Weather Agency and Federal Aviation Administration, both of which require 24/7 situational awareness.

Landsat Data Continuity Mission (+$13.35 million/3 FTE)

The USGS requests an increase of $13.35 million in 2011 to accommodate ground system requirements changes for LDCM associated with moving the Operational Land Imager (OLI) sensor to a free-flying satellite system and the addition of a Thermal Infrared Sensor (TIRS) on board the spacecraft. The Mission Operations Element (MOE) and the Flight Operations Team (FOT) are related to the implementation of LDCM as a free-flyer. The requested increase of $13.35 million in 2011 accommodates the additional ground system requirements, including the addition of a thermal sensor, and maintains NASA's mission schedule for the LDCM launch in December 2012.

Coastal and Marine Spatial Planning, PEO on Oceans (+$4.0 million/8 FTE)

Interior, with substantial coastal and ocean resource management responsibilities, has a critical role in implementation of the Administration's National Ocean Policy. The USGS, as the science and information bureau for Interior, will actively engage with other Interior bureaus and Federal agencies in implementation of the soon-to-be finalized "Framework for Effective Coastal and Marine Spatial Planning" (CMSP). CMSP includes implementation guidance for phased and collaborative development, including Federal, State, tribal, and other partners; to develop capacity, build on existing efforts, and leverage and gain efficiencies from lessons learned. The funds provided through this increase would support engagement of USGS and other Interior

bureaus in the incorporation of CMSP activities within the ocean governance structure and the development of a Strategic Action Plan (SAP) for CMSP implementation.

FWS/NPS/BLM Science Support (+$4.0 million/16 FTE)

The new funding will support research to increase the scientific information that will be available to FWS, BLM and NPS to inform resource management. Every year, the demand for research to support agency decisionmaking far exceeds the funding available. The additional funding will increase the number of USGS scientists that can work collaboratively with managers and biologists in these bureaus to develop and carry out research projects that address bureau management problems. Funding for FWS will be augmented by $1,500,000, and will include science support for adaptive management, and strategic and tactical research to meet the priority information needs identified by the FWS. A total of $1,500,000 will be added to programs that support NPS. Projects would include research on climate change adaptation and ecosystem change in parks, and other biological research, monitoring, and technical assistance of high priority to NPS. Support for BLM will be increased by $1,000,000 and will include nonforest fire research and ecoregional assessments of western systems.

Interagency Great Lakes Initiative ([+$10,300,000])

The 2011 budget request for the EPA includes $300.0 million for continuing work initiated in 2010 for restoration and protection of the Great Lakes. EPA, in concert with its Federal partners on the Great Lakes Interagency Task Force, will lead the development and implementation of a Great Lakes Restoration initiative. In 2011, programs and projects will continue strategically chosen to target the most significant problems in the Great Lakes ecosystem and to demonstrate measurable results.

EPA has used the strategic planning work of the Great Lakes Interagency Task Force to identify five principal environmental problems for which urgent action is required. The EPA may adjust the criteria in the future as a Great Lakes Restoration Plan is developed and refined. The initiative will focus protection and restoration activities on:

- Toxic Substances and Areas of Concern,
- Invasive Species,
- Nearshore Health and Nonpoint Source Pollution,
- Habitat and Wildlife Protection and Restoration
- Accountability, Education, Monitoring, Evaluation, Communication and Partnerships,

In 2010, USGS received $16.5 million to fund projects in these areas. In 2011, USGS anticipates it will receive $10.3 million to continue efforts.

This second year of the Initiative continues work the most significant environmental problems in the Great Lakes ecosystem. Programs and projects expected to be initiated in FY2011 were selected in a planning process conducted through the Great Lakes Interagency Task Force. Specific efforts were made to determine how second year funding could accomplish the goals and objectives identified in the Great Lakes Restoration Initiative Action Plan, recognizing each agency's mission and strengths. A specific emphasis has been placed upon implementation. This process includes competitive grant programs to implement the Initiative by funding States, Tribes, and other partners. Interagency Task Force members plan to work together to issue. EPA has led the Interagency Task Force in development of provisional funding targets. Upon receiving the FY2011 appropriation for the Initiative, EPA will determine final funding targets and

will develop a final 2011 funding plan, including grant programs. Key activities expected to advance environmental progress within each of the Initiative's focus areas.

The Great Lakes support a $7.0 billion annual fishery in addition to considerable revenue from tourism and recreation. Work by USGS scientists provides information to agencies and resource and land managers on deepwater science, invasive species, and wetlands and coastal habitat. The Great Lakes initiative will expand research to enhance ecosystem-based management of coastal resources by USGS partners. The USGS will integrate collaborative studies that provide forecast models and assessment to anticipate future coastal change and develop tools to effectively evaluate policy and management strategies to preserve the environmental and economic health of coastal systems.

Program Decreases

Component	2011 Program Change ($000)	Page Reference
National Map Partnership (Geography, NGP)	-3,500	I-29
LIDAR and High Risk Seismology (Geology, Earthquake)	-1,000	J-6
Coop Partnership, U of Hawaii-Manoa and USGS HVO (Geology, Volcano)	-250	J-18
Remove Congressional Add-on (Geology, GSN)	-250	J-31
Nye County, NV Mineral Resource Assessment (Geology, Minerals)	-650	J-59
San Diego, CA Aquifer Mapping (Water, Groundwater)	-900	K-6
Sparta Aquifer (Water, Groundwater)	-300	K-6
McHenry County, IL Groundwater (Water, Groundwater)	-280	K-6
Hood Canal (Water, HRD)	-200	K-29
Long-Term Estuary Group (Water, HRD)	-400	K-29
U.S.-Mexico Transboundry Aquifer (Water, HRD)	-1,000	K-29
Lake Champlain (Water, HNA)	-346	K-42
Water Monitoring in HI (Water, HNA)	-500	K-42
MD Coast and Piedmont Aquifer (Water, HNA)	-500	K-42
San Francisco Salt Pond Restoration (Biology, BRM)	-1,000	L-6
Conte Anadromous Fish Center (Biology, BRM)	-220	L-6
Genetics and Genomics Research (Biology, BRM)	-750	L-6
Tropical Ecosystem and Watershed Health (Biology, BRM)	-600	L-6
Invasive Species in Columbia River Basin (Biology, BRM)	-350	L-6
National Network of State Conservation Data Agencies (Biology, BIMD)	-1,428	L-29
NBII (Biology, BIMD)	-200	L-29
Enterprise Information and Security (EI, EIS&T)	-2,500	M-5
Enterprise Information Resources (EI, EIR)	-1,500	M-21
Total	**-18,624**	

***The National Map* Partnerships (-$3,500,000 / -4 FTE)**
For 2011, USGS proposes to reduce the funding for the Partnership Implementation component by $3.5 million which is currently funded at $13.9 million. The proposed reduction eliminates all funds used to specifically leverage with Federal, State and local agencies to acquire new data.

The proposed decrease would eliminate liaison positions in responsible for partnerships in 13 States. These positions organize the agreements through which USGS leverages its resources with those of State and local cooperators. They routinely provide coordination among Federal geospatial resources and those of State and local governments. Beyond these immediate outcomes, the reduction would result in reduced work for America's geospatial industry, which benefits by fulfilling contracts for projects that result from agreements the NGP makes with its cooperators.

LiDAR & Seismological Studies (-$1,000,000 / 0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of available requested resources. The general funding increase in 2010 was used to support LiDAR acquisition in high-hazard areas of the Pacific Northwest as well as seismic hazard investigations in areas of the Pacific Northwest and Southern California with high earthquake risk and community danger.

Cooperative partnership between the University of Hawaii-Manoa and the USGS Hawaii Volcano Observatory (-$250,000 / 0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of available requested resources. The funding increase was used to support a cooperative partnership between the University and the USGS Hawaii Volcano Observatory, focusing on a collaborative relationship that had been established between the two entities for monitoring, hazards assessments and other research in an area of almost continuous volcanic eruption.

Remove Congressional Add-on for Global Seismographic Network (-$250,000 / 0 FTE)
The reduction eliminates unrequested congressional funding and will keep the core program intact while allowing the USGS to make the best use of available requested resources.

Mineral Resource Assessment for Nye County, NV (-$650,000 / 0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to conduct a mineral resource assessment of Federal lands in Nye County, Nevada in collaboration with the University of Nevada, Las Vegas and the Nevada Bureau of Mines and Geology.

San Diego Aquifer Mapping (-$900,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used in mapping the San Diego Aquifer.

Arkansas Sparta Aquifer Recovery Initiative (-$300,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used for activities related to the Arkansas Sparta Aquifer Recovery Initiative.

McHenry County, IL Groundwater and Stormwater Project (-$280,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were supported work related to McHenry County, IL, Groundwater and Stormwater Project.

Hood Canal Dissolved Oxygen Study (-$270,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to support the Hood Canal Dissolved Oxygen Study.

Long Term Estuary Assessment Group (LEAG) (-$400,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to support activities related to LEAG.

U.S.-Mexico Transboundary Aquifer Assessment Act (-$500,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to support activities related to the U.S.-Mexico Transboundary Aquifer Assessment Act.

Lake Champlain Basin Toxic Material Study (-$346,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to support the Lake Champlain Basin Toxic Material Study. Base level funding ($154,000) for Lake Champlain efforts will continue.

Hawaii Water Resources Monitoring (-$500,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were use for activities related to Hawaii Water Resources Monitoring.

Maryland Coastal Plain Groundwater Modeling (-$500,000/0 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used to support activities related to Maryland Coastal Plain Groundwater Modeling. .

San Francisco Salt Ponds Studies (-$1,000,000/ -3 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used for interdisciplinary studies that support the restoration of San Francisco Bay Salt ponds and conversion of salt ponds to estuarine fish and wildlife habitat;

Conte Anadromous Fish Research Lab (-$220,000/ -1 FTE),
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds support ongoing basic and applied research for the improved management of habitat for endangered fish species, fish passage, natural resources, and ultimately the economy and environment of the Connecticut River watershed and Long Island Sound;

General genetics and genomic research (-$750,000/ -3 FTE),
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used for genetics research related to restoration of fisheries and mollusk populations and identification of disease agents along the Northeast and Mid-Atlantic coast, in the Great Lakes and in Northern Appalachia;

Tropical ecosystems and watershed health research (-$600,000/ -4 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used for multidisciplinary study of tropical watersheds and ecosystems that links land use, ecosystem stressors, hydrology, erosion, landscape restoration, and coral reef health in the Hawaiian islands.

Invasive species protocols in Columbia River Basin (-$350,000/ -2 FTE)
The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of requested available resources. These funds were used for monitoring and detection of zebra mussels and other aquatic invasive species in the Columbia River Basin.

State Conservation Data Agencies(-$1,428,000/ 0 FTE)
The proposed reduction to the Biological Information Management and Delivery (BIMD) in 2011 will reduce support to coordinators of the national network of State conservation data agencies to a total of $572,000. Because State agencies obviously operate within their own boundaries, there is a need to coordinate their data and information management efforts across state boundaries to facilitate collaboration for better cross-border resource management. This reduction limits assistance available to State agencies in managing and providing public access to conservation-related data and information.

National Biological Information Infrastructure (-$200,000/ 0 FTE)
The proposed reduction will diminish scientifically credible content within the National Biological Information Infrastructure (NBII) in the area of pollinator data and information. The result of this action is a deceleration of activity aimed at identifying pollinator data and information resources and making them available through the NBII for use by scientists and managers for conservation and biodiversity-related decisionmaking.

Enterprise Information Security and Technology IT Efficiencies (-$2,500,000 / -28.5 FTE)
Tthe need for USGS science continues to evolve as do the technological requirements, USGS anticipates technology costs will increase and decrease in a commensurate manner relative to programmatic needs. As a result, in 2011, the program will implement a new cost model for national technology services such as email, web, storage, bandwidth, directory and IT security services, that will balance dispersion of cost commensurate with service utilization. In support of

this action, the EIS&T program will restructure its workforce and services to create a flexible workforce and service offering that can be incrementally mobilized for science program needs. This action will result in a reduction-in-force of an estimated 28 Federal employees and reduced funding for contract and student positions.

EI Education and Information Dissemination (-$1,500,000 / -21 FTE)
The Enterprise Information Resources program includes the functions of science education, library services, information product distribution, public inquiry, and science quality oversight. This proposed reduction would eliminate 90 of the proposed 175 science education internships planned for 2011. This reduction would reduce the EIR education and internship activity resulting in reduced training for new jobs, a smaller increase in under-represented youth in the sciences, and educational opportunities in earth science. Tribal training will continue at the 2010 level.

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Analysis by Activity

(Dollars in Thousands)

Activity	2010 Enacted		DOI-Wide Changes b/ c/ (+/-)		Program Changes (+/-)		2011 Budget Request		Inc.(+) Dec.(-) from 2010	
	FTE a/	Amount	*FTE*	Amount	*FTE*	Amount	*FTE*	Amount	*FTE a/*	Amount
Geographic Research, Investigations, & Remote Sensing	*542*	145,590	*-12*	*-2,748*	*-1*	10,600	*529*	153,442	*-13*	7,852
Geologic Hazards., Resources, and Processes	*1,291*	249,131	*-12*	*-4,198*	*18*	8,900	*1,297*	253,833	*6*	4,702
Water Resources Investigations	*1,557*	232,307	*-35*	*-6,554*	*5*	3,074	*1,527*	228,827	*-30*	-3,480
Biological Research	*1,212*	204,944	*-10*	*-3,752*	*4*	152	*1,206*	201,344	*-6*	-3,600
Enterprise Information	*225*	45,969	*0*	*-468*	*-49*	-4,000	*176*	41,501	*-49*	-4,468
Global Change	*189*	58,177	*-1*	*-692*	*26*	14,614	*214*	72,099	*25*	13,922
Science Support	*375*	69,225	*56*	*8,159*	*0*	0	*431*	77,384	*56*	8,159
Facilities	*54*	106,397	*0*	*-1,468*	*0*	0	*54*	104,929	*0*	-1,468
TOTAL, SIR	***5,445***	**1,111,740**	***-14***	**-11,721**	***3***	**33,340**	***5,434***	**1,133,359**	***-11***	**21,619**

a/ The FTE depicted in the 2010 and 2011 columns are only the staff-years associated with appropriated funding. The following components comprise the difference between USGS appropriated FTE and total FTE: ARRA both Direct and Reimbursable are 31 and 0; Reimbursable FTE are 2,812 and 2,798; Working Capital Fund FTE are 284 and 282; Contributed Funds FTE are 7 and 7; and Allocation Accounts FTE are 17 and 17 for 2010 and 2011 respectively. USGS total FTE for 2010 and 2011 are 8,596 and 8,538 respectively. FTE may not add to totals and subtotals, due to rounding.

b/ Fixed costs changes for this account total $13,528 of which $13,528 is absorbed.

c/ DOI-Wide Changes column includes the following components: Related Changes including the following technical adjustments: (a) Regional Executive staff funding moved from various budget activities to Science Support budget activity (+$7,475), (b) Safety staff moved from various budget activities to Science Support budget activity (+$995), (c) EROS contract support moved to Science Support budget activity (+$284), and (d) creation of Construction budget sub-activity in the Facilities budget activity; DOI-Wide Management Efficiencies including the following savings: (a) travel (-$2,331), (b) IT (-$2,479), (c) acquisition (-$3,571), and (d) cost cutting (-$3,267); and DOI Working Capital Fund billing changes (-$73). For additional information related to these components, see the General Statement and the "DOI-Wide Explanation table" found later in this Section G.

United States Geological Survey

Federal Funds

General and special funds:

SURVEYS, INVESTIGATIONS, AND RESEARCH

For expenses necessary for the United States Geological Survey to perform surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States, its territories and possessions, and other areas as authorized by 43 U.S.C. 31, 1332, and 1340; classify lands as to their mineral and water resources; give engineering supervision to power permittees and Federal Energy Regulatory Commission licensees; administer the minerals exploration program (30 U.S.C. 641); conduct inquiries into the economic conditions affecting mining and materials processing industries (30 U.S.C. 3, 21a, and 1603; 50 U.S.C. 98g(1)) and related purposes as authorized by law; and to publish and disseminate data relative to the foregoing activities; **[**$1,111,740,000**]***$1,133,359,000*, to remain available until September 30, **[**2011**]***2012*, of which **[**$65,561,000**]***$63,598,000* shall be available only for cooperation with States or municipalities for water resources investigations; of which **[**$40,150,000**]***$53,500,000* shall remain available until expended for satellite operations; of which **[**$7,321,000**]***$4,807,000* shall be available until expended for deferred maintenance and capital improvement projects that exceed $100,000 in cost; of which *$2,500,000* shall be available until expended for construction; and of which $2,000,000 shall be available to fund the operating expenses for the Civil Applications Committee: Provided, That none of the funds provided for the biological research activity shall be used to conduct new surveys on private property, unless specifically authorized in writing by the property owner: Provided further, That no part of this appropriation shall be used to pay more than one-half the cost of topographic mapping or water resources data collection and investigations carried on in cooperation with States and municipalities. (*Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010*)

Justification of Proposed Language Change

1. Change: *of which $2,500,000 shall be available until expended for construction;*

   This is proposed as the result of the creation of a new budget sub-activity in the Facilities budget activity, entitled “Construction”. This new budget sub-activity is funded at $2,500,000 and is no-year funding.

Appropriation Language and Citations

1. For expenses necessary for the United States Geological Survey to perform surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States,

   - **43 U.S.C. 31(a)** provides for establishment of the Office of the Director of the Geological Survey, under the Interior Department, and that this officer shall have direction of the Geological Survey, and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain.

2. its territories and possessions, and other areas as authorized by law.

   - **43 U.S.C 31(b)** provides that, "The authority of the Secretary of the Interior, exercised through the Geological Survey of the Department of the Interior, to examine the geological structure, mineral resources, and products of the national domain, is expanded to authorize such examinations outside the national domain where determined by the Secretary to be in the national interest."

   - **43 U.S.C. 1332(a)** provides that, "It is the declared policy of the United States, that the subsoil and seabed of the Outer Continental Shelf appertain to the United States and are subject to its jurisdiction, control, and power of disposition as provided in this subchapter."

   - **43 U.S.C. 1340** provides that, "Any agency of the United States and any person authorized by the Secretary may conduct geological and geophysical exploration in the Outer Continental Shelf. ..."

3. classify lands as to their mineral and water resources;

   - **43 U.S.C. 31(a)** provides that, "The Director of the Geological Survey, ... shall have the direction of the Geological Survey, and the classification of public lands and examination of the geological structure, mineral resources, and products in the National domain. ..."

4. give engineering supervision to power permittees

   - **43 U.S.C. 959** provides that, "The Secretary of the Interior is authorized and empowered, ... to permit the use of right of way through the public lands, forest, and other reservations of the United States ... for electrical plants, poles, and lines for the generation and distribution of electrical power, ...**Provided**, that such permits shall be allowed within or through any of said parks or any forest, military, Indian, or other reservation only upon approval of the Chief Officer of the Department under whose supervision such park or reservation falls and upon a finding by him that the same is not incompatible with the public interest ..."

   - **43 U.S.C. 961** provides that, "The head of the department having jurisdiction over the lands be, and he is, authorized and empowered, ... to grant an easement for right of way, ... over, across and upon the public lands and reservations of the United States for

- electrical poles and lines for the transmission and distribution of electrical power ... upon a finding by him that the same is not incompatible with the public interest ..."

5. and Federal Energy Regulatory Commission licensees;

   - **16 U.S.C. 797(c)** states that, "To cooperate with the executive departments and other agencies of States or National Governments in such investigations; and for such purposes the several departments and agencies of the National Government are authorized and directed upon the request of the commission, to furnish such records, papers and information in their possession as may be requested by the commission, and temporarily to detail to the commission such officers or experts as may be necessary in such investigations."

6. administer the minerals exploration program;

   - **30 U.S.C. 641** provides that, "The Secretary of the Interior is hereby authorized and directed, in order to provide for discovery of additional domestic mineral reserves, to establish and maintain a program for exploration by private industry within the United States, its territories and possessions for such minerals, excluding organic fuels, as he shall from time to time designate, and to provide Federal financial assistance on a participating basis for that purpose."

7. publish and disseminate data relative to the foregoing activities;

   - **43 U.S.C. 41** provides for the publication of geological and economic maps, illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. This section also provides for the scientific exchange and sale of such published material.

   - **44 U.S.C. 1318** provides for publication, by the Geological Survey, of various reports, including a report of mineral resources of the United States, bulletins and professional papers, and monographs. This section also specifies, in some instances, numbers of copies to be printed and the distribution thereof.

   - **44 U.S.C. 1320** provides for the distribution by the Director of the Geological Survey of copies of sale publications to public libraries.

8. and to conduct inquiries into the economic conditions affecting mining and materials processing industries...and related purposes as authorized by law and to publish and disseminate data;

   - **30 U.S.C. 3** provides for inquiry into the economic conditions affecting the mining, quarrying, metallurgical, and other minerals industries. This section also provides for the dissemination of information concerning these industries.

   - **30 U.S.C. 21(a)** provides for an annual report on the state of the domestic mining minerals, and mineral reclamation industries, including a statement of the trend in utilization and depletion of resources.

- **30 U.S.C. 1603** provides for ...improved collection, analysis, and dissemination of scientific, technical and economic materials information and data from Federal, state, and local governments, and other sources as appropriate.

- **50 U.S.C. 98g(1)** provides for scientific, technologic, and economic investigations concerning the development, mining, preparation, treatment, and utilization of ore and other mineral substances.

9. of which ( ) shall be available only for cooperation with States or municipalities for water resources investigations;

- **43 U.S.C. 48** provides that, "...amounts received by the Geological Survey from any State, Territory or political subdivision thereof in carrying on work involving cooperation to be used in reimbursing the appropriation from which the expense of such work was paid, was from the act making appropriations for the Department of the Interior for the fiscal year ending June 30, 1928, and for other purposes, act January 12, 1927, ch. 277, 1, 44 Stat. 963, and has not been repeated in subsequent appropriation acts."

- Similar provisions were contained in the following act: 1926 - May 10, 1926, ch. 277, 1, 44 Stat. 487.

10. of which ( ) shall remain available until expended for satellite operations;

- **P.L. 107–43, Department of the Interior and Related Agencies Appropriation Act, 2002**

11. of which ( ) shall be available until September 30, ( ), for the operation and maintenance of facilities and deferred maintenance;

- **P.L. 106–291, Department of the Interior and Related Agencies Appropriations Act, 2001**

12. of which $1,600,000 shall be available until expended for deferred maintenance and capital improvement projects that exceed $100,000 in cost;

- **P.L. 108–447, Consolidated Appropriations Act, 2005 (Interior and Related Agencies portion)**

13. and of which ( ) shall be available until September 30, ( ), for the biological research activity and the operation of the Cooperative Research Units;

- **P.L. 104–208, Omnibus Appropriations Act, 1997 (Interior and Related Agencies portion)**

14. *Provided*, That none of these funds provided for the biological research activity shall be used to conduct new surveys on private property, unless specifically authorized in writing by the property owner:

- **P.L. 104–208, Omnibus Appropriations Act. 1997 (Interior and Related Agencies portion)**

15. Provided further, That no part of this appropriation shall be used to pay more than one-half the cost of topographic mapping or water resources data collections and investigations carried on in cooperation with States and municipalities.

    - **43 U.S.C. 50** provides that, "The share of the Geological Survey in any topographic mapping or water resources investigations carried on in cooperation with any State or municipality shall not exceed 50 per centum of the cost thereof. ..."

Permanent authority:

16. Provided further, that in fiscal year 1984 and thereafter, all receipts from the sale of maps sold or stored by the Geological Survey shall be available for map printing and distribution to supplement funds otherwise available, to remain available until expended.

    - **43 U.S.C. 42a** Provided further, That in fiscal year 1986 and thereafter, all amortization fees resulting from the Geological Survey providing telecommunications services shall be deposited in a special fund to be established on the books of the Treasury and be immediately available for payment of replacement or expansion of telecommunications services, to remain available until expended.

    - **43 U.S.C. 50a** with the establishment of the Working Capital Fund (WCF) in FY 1991, the Telecommunications Amortization Fund account and its end of year FY 1990 balances were included in the WCF.

17. Provided further, that, heretofore and hereafter, in carrying out work involving cooperation with any State, Territory, possession, or political subdivision thereof, the Geological Survey may, notwithstanding any other provisions of law, record obligations against accounts receivable from any such entities and shall credit amounts received from such entities to this appropriation.

    - **43 U.S.C. 50b**

18. Provided further, That in Fiscal Year 1987 and thereafter the Geological Survey is authorized to accept lands, buildings, equipment, and other contributions from public and private sources and to prosecute projects in cooperation with other agencies, Federal, State, or private.

    - **43 U.S.C. 36c** This authority for contributions was in the appropriation language annually from FY 1983 through FY 1986 and was made permanent in FY 1987.

19. Provided, That upon enactment of this Act and hereafter, final costs related to the National Petroleum Reserve in Alaska may be paid from available prior year balances in this account.

    - **P.L. 100–446, Department of the Interior and Related Agencies Appropriations Act, 1989**

20. Established a Working Capital Fund which is detailed in the Working Capital Fund section of this book.

    - **P.L. 101–512, Department of the Interior and Related Agencies Appropriations Act, 1991**

21. Provided further, That beginning October 1, 1990, and thereafter, funds received from any State, territory, possession, country, international organization, or political subdivision thereof, for topographic, geologic, or water resources mapping or investigations involving cooperation with such an entity shall be considered as intragovernmental funds as defined in the publication titled "A Glossary of Terms Used in the Federal Budget Process."

    - **P.L. 101–512, Department of the Interior and Related Agencies Appropriations Act, 1991**

    This authority exempts non-Federal cooperative funds from sequester as defined in 1985 amendments (P.L. 99–177) to the Budget Impoundment and Control Act of 1974.

22. Provided further, That beginning in fiscal year 1998 and once every five years thereafter, the National Academy of Sciences shall review and report on the biological research activity of the Survey:

    - **P.L. 104–208, Omnibus Appropriations Act, 1997 (Interior and Related Agencies portion)**

Administrative Provisions

From within the amount appropriated for activities of the United States Geological Survey such sums as are necessary shall be available for reimbursement to the General Services Administration for security guard services; contracting for the furnishing of topographic maps and for the making of geophysical or other specialized surveys when it is administratively determined that such procedures are in the public interest; construction and maintenance of necessary buildings and appurtenant facilities; acquisition of lands for gauging stations and observation wells; expenses of the United States National Committee on Geology; and payment of compensation and expenses of persons on the rolls of the Survey duly appointed to represent the United States in the negotiation and administration of interstate compacts: *Provided*, That activities funded by appropriations herein made may be accomplished through the use of contracts, grants, or cooperative agreements as defined in 31 U.S.C. 6302 et seq.: *Provided further*, That the United States Geological Survey may enter into contracts or cooperative agreements directly with individuals or indirectly with institutions or nonprofit organizations, without regard to 41 U.S.C. 5, for the temporary or intermittent services of students or recent graduates, who shall be considered employees for the purpose of chapters 57 and 81 of title 5, United States Code, relating to compensation for travel and work injuries, and chapter 171 of title 28, United States Code, relating to tort claims, but shall not be considered to be Federal employees for any other purposes. (*Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010*.)

Justification of Proposed Administrative Provisions Language Change

The USGS does not propose any administrative provisions language changes to the 2011 President's Budget request.

Administrative Provisions Language and Citations

1. From within the amount appropriated for activities of the United States Geological Survey such sums as are necessary shall be available for reimbursement to the General Services Administration for security guard services; contracting for the furnishing of topographic maps and for the making of geophysical or other specialized surveys when it is administratively determined that such procedures are in the public interest;

   - **No specific authority**. These provisions are required by reason of rulings of the Comptroller General that specific authority is required for reimbursing the General Services Administration for guard services (B–87255); and for contracting with private persons for the performance of duties with which the agency is specifically charged (15 Comp. Gen. 951).

2. construction and maintenance of necessary buildings and appurtenant facilities;

   - **No specific authority.** The Organic Act of 1879, establishing the Geological Survey and providing for "... examination of the geological structure, mineral resources, and products of the national domain" (43 U.S.C. 31) is general authorization for construction of special-purpose laboratory buildings. Specific authorization by the Congressional committees on public works is not needed because of the highly specialized purposes of the building. 40 U.S.C. 612: "The term 'public building' means any building ... which is generally suitable for office or storage space ... but shall not include any such buildings and construction projects: ... (E) on or used in connection with ... or for nuclear production, research, or development projects." 41 U.S.C. 12: "No contract shall be entered into for the erection, repair, or furnishing of any public building ... which shall bind the government to pay a larger sum of money than the amount in the Treasury appropriated for the specific purpose."

3. acquisition of lands for gauging stations and observation wells;

   - **43 U.S.C. 36(b)** provides that, "The Secretary of the Interior may, on behalf of the

     United States and for the use by the Geological Survey in gaging streams and underground water resources, acquire lands by donation or when funds have been appropriated by Congress by purchase or condemnation ...."

4. expenses of the U.S. National Committee on Geology;

   - **43 U.S.C. 31** participation in and payment of expenses of the U.S. National Committee on Geology is a proper and necessary function of the Geological Survey, and so is authorized by the Survey's Organic Act of March 3, 1879, 43 U.S.C. 31. This Act provides that, "...The Director of the Geological Survey, which office is established, under the Interior Department, shall be appointed by the President by and with the advice and consent of the Senate. This officer shall have the direction of the Geological Survey, and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain ...."

5. and payment of compensation and expenses of persons on the rolls of the Survey duly appointed to represent the United States in the negotiation and administration of interstate compacts:

   - **66 Stat. 453.** The above language first appeared in the Appropriation Act for FY 1953, P.L. 82–470 (66 Stat. 453), and has been repeated in each Act since that date. Article I, Section 10, paragraph 3, of the United States Constitution provides that, No State shall, without the consent of Congress, lay any duty on tonnage, keep troops, or ships of war in time of peace, enter into any agreement or compact with another State, or with a foreign power, or engage in war, unless actually invaded, or in such imminent danger as will not admit or delay." (emphasis supplied)

   Thus each interstate compact must be approved by the Congress and signed by the President. The Public Law approving each interstate compact represents the authorizing legislation.

6. *Provided*, That activities funded by appropriations herein may be accomplished through the use of contracts, grants, or cooperative agreements as defined in 31 U.S.C. 6302, et seq.

   - The above language appears in the Department of the Interior and Related Agencies Appropriations Act, 1988, as included in Public Law 100–202.

7. *Provided further,* That the United States Geological Survey may enter into contracts or cooperative agreements directly with individuals or indirectly with institutions or nonprofit organizations, without regard to 41 U.S.C. 5, for the temporary or intermittent services of students or recent graduates, who shall be considered employees for the purpose of chapters 57 and 81 of title 5, United States Code, relating to compensation for travel and work injuries, and chapter 171 of title 28, United States Code, relating to tort claims, but shall not be considered to be Federal employees for any other purposes.

   - The above language appears in the Consolidated Appropriations Act, 2005 (Interior and Related Agencies portion), as included in Public Law 108–447.

Permanent Authority:

1. *Provided*, That appropriations herein and hereafter made shall be available for paying costs incidental to the utilization of services contributed by individuals who serve without compensation as volunteers in aid of work of the Geological Survey, and that within appropriations herein and hereafter provided, Geological Survey officials may authorize either direct procurement of or reimbursement for expenses incidental to the effective use of volunteers such as, but not limited to, training, transportation, lodging, subsistence, equipment, and supplies.

   - **43 U.S.C. 50c**

2. *Provided further*, That provision for such expenses or services is in accord with volunteer or cooperative agreements made with such individuals, private organizations, educational institutions, or State or local government.

   - **43 U.S.C 31(a)**

3. *Provided further*, That the Geological Survey (43 U.S.C. 31(a)) shall hereafter be designated the United States Geological Survey.

   - **Department of the Interior and Related Agencies Appropriations Act, 1992, as included in Public Law 102–154.**

4. *Provided further*, That the United States Geological Survey may hereafter contract directly with individuals or indirectly with institutions or nonprofit organizations, without regard to 41 U.S.C. 5, for the temporary or intermittent services of students or recent graduates, who shall be considered employees for the purposes of chapters 57 and 81 of title 5, United States Code, relating to compensation for travel and work injuries, and Chapter 171 of Title 28, United States Code, relating to tort claims, but shall not be considered to be a Federal employees for any other purposes.

   - **Department of the Interior and Related Agencies Appropriations Act, 2000, as included in Public Law 106–113.**

5. *Provided further,* That notwithstanding the provisions of the Federal Grant and Cooperative. Agreement Act of 1977 (31 U.S.C. 6301–6308), the may be United States Geological Survey is authorized to continue existing, and hereafter, to enter into new cooperative agreements directed towards a particular cooperator, in support of joint research and data collection activities with Federal, State, and academic partners funded by appropriations herein, including those that provide for space in cooperator facilities.

   - **Department of the Interior and Related Agencies Appropriations Act, 2004, as included in Public Law 108–108.**

Justification of Fixed Costs and Related Changes: USGS

(Dollars in Thousands)

	2010 Budget	2010 Revised	2011 Fixed Costs And Related Changes
Additional Operational Costs from 2010 and 2011 Jan Pay Raises			
1. 2010 Pay Raise, 3 Quarters in 2010 Budget	+$8,278	+$8,278	NA
Amount of pay raise absorbed	*[$0]*	*[$0]*	*NA*
2. 2010 Pay Raise, 1 Quarter (Enacted 2.0%)	NA	NA	NA
Amount of pay raise absorbed			*[+$2,714]*
3. 2011 Pay Raise (Proposed 1.4%)	NA	NA	NA
Amount of pay raise absorbed			*[+$5,698]*

These adjustments are for an additional amount needed to fund estimated pay raises for Federal employees.

Line 1, 2010 Revised column is an update of 2010 budget estimates based upon an enacted 2.0%.

Line 2 is the amount needed in 2011 to fund the estimated 2.0% January 2010 pay raise from October through December 2010.

Line 3 is the amount needed in 2011 to fund the estimated 1.4% January 2011 pay raise from January through September 2011.

The estimated cost increase will be absorbed through increased efficiencies such as delayering organizations, re-examining position grades, management streamlining, and business process improvement.

	2010 Budget	2010 Revised	2011 Fixed Costs And Related Changes
Other Fixed Cost Changes			
One Less Pay Day	NA	NA	NA

The number of paid days is constant in 2011.

Non-Foreign Area COLA – Locality Pay Adjustment			NA
Amount of Non-Foreign Area COLA – Locality Pay absorbed			*[+$744]*

This adjustment is for changes to pay and benefits for Federal employees stationed in U.S. States, territories, and possessions outside of the continental United States. Specifically, the Non-foreign Area Retirement Equity Assurance Act, as contained in subtitle B (section 1911-1919) of the title XIX of the National Defense Authorization Act (NDAA) for Fiscal Year 2010 (P.L. 111-84) transitions the non-foreign area cost-of-living allowance (COLA) authorized under 5 U.S.C. 5941(a)(1) to locality pay authorized under 5 U.S.C. 5304 in the non-foreign areas as listed in 5 CFR 591 205. The Act also extends locality pay to America Samoa and other non-foreign territories and possessions of the United States where no COLA rate applies. The estimated cost increase will be absorbed.

Employer Share of Federal Health Benefit Plans	+$2,158	+$2,158	NA
Amount of health benefits absorbed	*[$0]*	*[$0]*	*[+$2,502]*

This adjustment is for changes in the Federal government's share of the cost of health insurance coverage for Federal employees. For 2011, the increase is estimated at 7.0%. The estimated increase cost will be absorbed.

	2010 Budget	2010 Revised	2011 Fixed Costs And Related Changes
Other Fixed Cost Changes (continued)			
Worker's Compensation Payments	$3,010	$3,010	NA
Amount of worker's compensation payments absorbed	*[$0]*	*[$0]*	*[+$90]*
The adjustment is for actual charges through June 2009, in the costs of compensating injured employees and dependents of employees who suffer accidental deaths while on duty. Costs for 2011 will reimburse the Department of Labor, Federal Employees Compensation Fund, pursuant to 5 U.S.C. 8147(b) as amended by Public Law 94–273. The estimated cost increase will be absorbed.			
Unemployment Compensation Payments	$668	$668	NA
Amount of unemployment compensation payments absorbed	*[$0]*	*[$0]*	*[+$43]*
The adjustment is for estimated changes in the costs of unemployment compensation claims to be paid to the Department of Labor, Unemployment Trust Fund, pursuant to Public Law 96–499. The estimated cost increase will be absorbed.			
Rental Payments	$68,478	$68,478	NA
Amount of rental payments absorbed	*[$0]*	*[$0]*	*[+$1,080]*
The adjustment is for changes in the costs payable to General Service Administration (GSA) and others resulting from changes in rates for office and non-office space as estimated by GSA, as well as the rental costs of other currently occupied space. These costs include building security; in the case of GSA space, these are paid to DHS. Costs of mandatory office relocations, i.e., relocations in cases where due to external events there is no alternative but to vacate the currently occupied space, are also included. The estimated cost increase will be absorbed.			
Increased Staff in 2010	NA	NA	NA
Amount of health benefits absorbed			*[+$657]*
This adjustment is for funding related to increased 2010 staffing needs. The estimated increase cost will be absorbed.			
Department Working Capital Fund	$17,565	$17,565	NA
Amount of working capital fund absorbed	*[$0]*	*[$0]*	
The Working Capital Fund funding estimate for 2011 is being held very close to level with 2010 by reallocating internal priorities and reducing lower priority services.			

Related Changes – Internal Transfers and Other Changes	
Travel Savings	-$2,331
USGS will save $2,331 by reducing travel and relocation expenditures through adoption of new technologies and efficiency improvements. An additional description of these savings can be found in the General Statement section.	
Information Technology Savings	-$2,479
USGS will save $2,479 through effectiveness and efficiencies in information technology. An additional description of these savings can be found in the General Statement section.	
Acquisition Savings	-$3,571
USGS will save $3,571 as a result of the expansion of strategic sourcing for enterprise acquisitions. An additional description of these savings can be found in General Statement section.	
Cost Cutting Savings	-$3,267
USGS will save $3,267 by reducing costs in rent, energy efficiencies at facilities, savings from work force planning, administration support consolidations in the field, elimination of competitive sourcing studies, and other activities. An additional description of these savings can be found in the General Statement section.	
Department Working Capital Fund Adjustments	-$73
The Working Capital Fund funding estimate for 2011 contains a series of funding adjustments that result in a net savings of $73.	

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Summary of Requirements
(Dollars in Thousands)

Appropriation: Surveys, Investigations, and Research

	FTE	Absorbed Amount	FTE	Amount
Budget estimate, 2010 Enacted			5,445	1,111,740
DOI-Wide Changes:				
Additional Cost in 2011 of January 2010 Pay Raise		*[+2,714]*		0
Additional Cost in 2011 of January 2011 Pay Raise		*[+5,698]*		0
Non-Foreign Area COLA – Locality Pay Adjustment		*[+744]*		0
Employer Share of Federal Health Benefit Plans		*[+2,502]*		0
Worker's Compensation Payments		*[+90]*		0
Unemployment Compensation Payments		*[+43]*		0
Rental Payments		*[+1,080]*		0
Increased Staff in 2010		*[+657]*		0
Department Working Capital Fund Charges				0
Subtotal, Fixed Cost Adjustments		*[+13,528]*		0
Technical Adjustment and Internal Transfers			-14	0
Travel Savings				-2,331
Information Technology Savings				-2,479
Acquisition Savings				-3,571
Cost Cutting Efficiencies				-3,267
Subtotal, DOI-Wide Management Efficiencies				-11,648
Department Working Capital Fund Adjustments				-73
Total, DOI-Wide Changes			-14	-11,721
Program Change			+3	+33,340
TOTAL REQUIREMENTS			5,434	1,133,359

Summary of Requirements
(Dollars in Thousands)

Activity/Subactivity/Program Element	2009 Actual		2009 Recovery Act b/		2010 Enacted		DOI-Wide Changes c/ d/ (+/-)		Program Changes (+/-)		2011 Budget Request		Inc.(+) Dec.(-) from 2010	
	FTE a/	Amount	*FTE a/*	Amount	*FTE a/*	Amount	*FTE*	Amount	*FTE*	Amount	*FTE a/*	Amount	*FTE*	Amount
GEOG RES., INVESTIGATIONS & REMOTE SENSING														
Land Remote Sensing	*142*	61,718	*0*	0	146	63,707	*-8*	-1,195	*3*	13,350	*141*	75,862	*-5*	12,155
Geographic Analysis and Monitoring	*66*	10,598	*0*	0	66	11,135	*-1*	-192	*0*	750	*65*	11,693	*-1*	558
National Geospatial Program					330	70,748	*-3*	-1,361	*-4*	-3,500	*323*	65,887	*-7*	-4,861
TOTAL	*208*	72,316	*0*	0	*542*	145,590	*-12*	-2,748	*-1*	10,600	*529*	153,442	*-13*	7,852
GEOLOGIC HAZ., RESOURCES, & PROC.														
Geologic Hazard Assessments														
Earthquake Hazards	*248*	55,760	*0*	0	*247*	57,021	*-3*	-930	*3*	800	*247*	56,891	*0*	-130
Volcano Hazards	*143*	23,901	*0*	29,445	*143*	24,421	*-1*	-458	*2*	1,250	*144*	25,213	*1*	792
Landslide Hazards	*22*	3,350	*0*	15,210	*22*	3,405		-80		0	*22*	3,325	*0*	-80
Global Seismographic Network	*10*	5,482	*0*	0	*10*	5,778		-138		-250	*10*	5,390	*0*	-388
Geomagnetism	*17*	2,092	*0*	0	*16*	2,138		-37		0	*16*	2,101	*0*	-37
Subtotal	*440*	90,585	*0*	44,655	*438*	92,763	*-4*	-1,643	*5*	1,800	*439*	92,920	*1*	157
Geologic Landscape & Coastal Assessments														
National Cooperative Geologic Mapping	*131*	27,724	*0*	0	*131*	28,163	*-1*	-395		500	*130*	28,268	*-1*	105
Coastal and Marine Geology	*228*	44,657	*0*	0	*227*	46,188	*-2*	-871	*8*	4,000	*233*	49,317	*6*	3,129
Subtotal	*359*	72,381	*0*	0	*358*	74,351	*-3*	-1,266	*8*	4,500	*363*	77,585	*5*	3,234
Geologic Resource Assessments														
Mineral Resources	*345*	52,427	*0*	0	*344*	53,780	*-3*	-858		-400	*341*	52,522	*-3*	-1,258
Energy Resources	*151*	26,749	*0*	0	*151*	28,237	*-2*	-431	*5*	3,000	*154*	30,806	*3*	2,569
Subtotal	*496*	79,176	*0*	0	*495*	82,017	*-5*	-1,289	*5*	2,600	*495*	83,328	*0*	1,311
TOTAL	*1,295*	242,142	*0*	44,655	*1,291*	249,131	*-12*	-4,198	*18*	8,900	*1,297*	253,833	*6*	4,702
WATER RESOURCES INVESTIGATIONS														
Hydrologic Monitoring, Assessments & Research														
Groundwater Resources Program	*54*	9,008	*0*	0	*53*	9,714	*-1*	-236		-380	*52*	9,098	*-1*	-616
National Water-Quality Assessment	*380*	65,056	*0*	0	*379*	66,507	*-3*	-1,465		0	*376*	65,042	*-3*	-1,465
Toxic Substances Hydrology	*36*	10,767	*0*	0	*36*	11,084	*-1*	-284		0	*35*	10,800	*-1*	-284
Hydrologic Research & Development	*214*	13,421	*0*	0	*213*	13,822	*-1*	-266		-1,600	*212*	11,956	*-1*	-1,866
National Streamflow Information Program	*49*	22,406	*0*	14,625	*49*	27,732	*-2*	-578		0	*47*	27,154	*-2*	-578
Hydrologic Networks and Analysis	*149*	30,128	*0*	0	*149*	31,387	*-7*	-1,761	*5*	5,054	*147*	34,680	*-2*	3,293
Subtotal	*882*	150,786	*0*	14,625	*879*	160,246	*-15*	-4,590	*5*	3,074	*869*	158,730	*-10*	-1,516
Cooperative Water Program	*679*	64,078	*0*	0	*676*	65,561	*-20*	-1,963		0	*656*	63,598	*-20*	-1,963
Water Resources Research Act Program	*2*	6,500	*0*	0	*2*	6,500		-1		0	*2*	6,499	*0*	-1
TOTAL	*1,563*	221,364	*0*	14,625	*1,557*	232,307	*-35*	-6,554	*5*	3,074	*1,527*	228,827	*-30*	-3,480

Summary of Requirements
(Dollars in Thousands)

Activity/Subactivity/Program Element	2009 Actual		2009 Recovery Act b/		2010 Enacted		DOI-Wide Changes c/ d/ (+/-)		Program Changes (+/-)		2011 Budget Request		Inc.(+) Dec.(-) from 2010	
	FTE a/	Amount	*FTE a/*	Amount	*FTE a/*	Amount	*FTE*	Amount	*FTE*	Amount	*FTE a/*	Amount	*FTE*	Amount
BIOLOGICAL RESEARCH														
Biological Research and Monitoring	*972*	146,416	*0*	0	*998*	160,685	*-8*	-3,014	*4*	1,780	*994*	159,451	*-4*	-1,234
Biological Information Management & Delivery	*74*	21,965	*0*	0	*73*	24,946	*-2*	-568		-1,628	*71*	22,750	*-2*	-2,196
Cooperative Research Units	*126*	16,949	*0*	0	*141*	19,313		-170		0	*141*	19,143	*0*	-170
TOTAL	*1,172*	185,330	*0*	0	*1,212*	204,944	*-10*	-3,752	*4*	152	*1,206*	201,344	*-6*	-3,600
ENTERPRISE INFORMATION														
Enterprise Information Security and Technology	*86*	25,176	*0*	0	*86*	26,263	*0*	-286	*-28*	-2,500	*58*	23,477	*-28*	-2,786
Enterprise Information Resources	*113*	17,478	*0*	0	*139*	19,706	*0*	-182	*-21*	-1,500	*118*	18,024	*-21*	-1,682
National Geospatial Program	*332*	69,816	*0*	14,625										
TOTAL	*531*	112,470	*0*	14,625	*225*	45,969	*0*	-468	*-49*	-4,000	*176*	41,501	*-49*	-4,468
GLOBAL CHANGE	*152*	40,628	*0*	0	*189*	58,177	*-1*	-692	*26*	14,614	*214*	72,099	*25*	13,922
SCIENCE SUPPORT	*376*	67,430	*9*	3,788	*375*	69,225	*56*	8,159	*0*	0	*431*	77,384	*56*	8,159
FACILITIES														
Rental Payments and Operations & Maintenance	*54*	94,802	*0*	0	*54*	99,076	*0*	-1,454	*0*	0	*54*	97,622	*0*	-1,454
Deferred Maintenance & Capital Improvement		7,321	*0*	62,307		7,321	*0*	-2,514	*0*	0	*0*	4,807	*0*	-2,514
Construction							*0*	2,500	*0*	0	*0*	2,500	*0*	2,500
TOTAL	*54*	102,123	*0*	62,307	*54*	106,397	*0*	-1,468	*0*	0	*54*	104,929	*0*	-1,468
TOTAL, SIR	***5,351***	**1,043,803**	***9***	**140,000**	***5,445***	**1,111,740**	***-14***	**-11,721**	***3***	**33,340**	***5,434***	**1,133,359**	***-11***	**21,619**

a/ The FTE depicted in the 2009, 2010, and 2011 columns are only the staff-years associated with appropriated funding. The following components comprise the difference between USGS appropriated FTE and total FTE: ARRA both Direct and Reimbursable are 10, 31, and 0; Reimbursable FTE are 2,812, 2,812 and 2,798; Working Capital Fund FTE are 285, 284 and 282; Contributed Funds FTE are 7, 7, and 7; and Allocation Accounts FTE are 17, 17, and 17 for 2009, 2010 and 2011 respectively. USGS total FTE for 2009, 2010, and 2011 are 8,482, 8,596 and 8,538 respectively. FTE may not add to totals and subtotals, due to rounding.

b/ A new treasury account was created for the Recovery Act appropriation; direct allocations to programs were not made.

c/ Fixed costs changes for this account total $13,528 of which $13,528 is absorbed.

d/ DOI-Wide Changes column includes the following components: Related Changes including the following technical adjustments: (a) Regional Executive staff funding moved from various budget activities to Science Support budget activity (+$7,475), (b) Safety staff moved from various budget activities to Science Support budget activity (+$995), (c) EROS contract support moved to Science Support budget activity (+$284), and (d) creation of Construction budget sub-activity in the Facilities budget activity; DOI-Wide Management Efficiencies including the following savings: (a) travel (-$2,331), (b) IT (-$2,479), (c) acquisition (-$3,571), and (d) cost cutting (-$3,267); and DOI Working Capital Fund billing changes (-$73). For additional information related to these components, see the General Statement and the "DOI-Wide Explanation table" found later in this Section G.

Details for DOI-Wide Changes a/
(Dollars in Thousands)

Activity/Subactivity/Program Element	Related Changes - Budget Restructures: Regional Executive Staff	Safety Staff	EROS Contract Support	Facilities Construct Sub-act	Subtotal	DOI-Wide Management Efficiencies: Travel Savings	Information Technology Savings	Acquisition Savings	Cost Cutting Efficiencies	Subtotal	DOI WCF Adjustments	Total
GEOG RES., INVESTIGATIONS & REMOTE SENSING												
Land Remote Sensing	-507	0	-284	0	-791	-106	-66	-232	0	-404	0	-1,195
Geographic Analysis and Monitoring	-81	0	0	0	-81	-34	-31	-18	-28	-111	0	-192
National Geospatial Program	-564	0	0	0	-564	-191	-153	-273	-180	-797	0	-1,361
TOTAL	-1,152	0	-284	0	-1,436	-331	-250	-523	-208	-1,312	0	-2,748
GEOLOGIC HAZ., RESOURCES, & PROC.												
Geologic Hazard Assessments												
Earthquake Hazards	-325	-74	0	0	-399	-118	-115	-156	-142	-531	0	-930
Volcano Hazards	-153	-35	0	0	-188	-62	-66	-81	-61	-270	0	-458
Landslide Hazards	-26	-6	0	0	-32	-15	-10	-14	-9	-48	0	-80
Global Seismographic Network	-43	-10	0	0	-53	-5	-5	-61	-14	-85	0	-138
Geomagnetism	-16	-3	0	0	-19	-5	-8	0	-5	-18	0	-37
Subtotal	-563	-128	0	0	-691	-205	-204	-312	-231	-952	0	-1,643
Geologic Landscape & Coastal Assessments												
National Cooperative Geologic Mapping	-145	-33	0	0	-178	-51	-61	-34	-71	-217	0	-395
Coastal and Marine Geology	-316	-72	0	0	-388	-103	-106	-156	-118	-483	0	-871
Subtotal	-461	-105	0	0	-566	-154	-167	-190	-189	-700	0	-1,266
Geologic Resource Assessments												
Mineral Resources	-405	-92	0	0	-497	-87	-159	-115	0	-361	0	-858
Energy Resources	-200	-45	0	0	-245	-62	-70	-54	0	-186	0	-431
Subtotal	-605	-137	0	0	-742	-149	-229	-169	0	-547	0	-1,289
TOTAL	-1,629	-370	0	0	-1,999	-508	-600	-671	-420	-2,199	0	-4,198
WATER RESOURCES INVESTIGATIONS												
Hydrologic Monitoring, Assessments & Research												
Groundwater Resources Program	-88	-16	0	0	-104	-42	-25	-44	-21	-132	0	-236
National Water-Quality Assessment	-409	-75	0	0	-484	-237	-176	-399	-169	-981	0	-1,465
Toxic Substances Hydrology	-88	-16	0	0	-104	-35	-17	-100	-28	-180	0	-284
Hydrologic Research & Development	-88	-16	0	0	-104	-21	-99	-11	-31	-162	0	-266
National Streamflow Information Program	-292	-54	0	0	-346	-84	-23	-55	-70	-232	0	-578
Hydrologic Networks and Analysis	-1,141	-210	0	0	-1,351	-154	-69	-111	-76	-410	0	-1,761
Subtotal	-2,106	-387	0	0	-2,493	-573	-409	-720	-395	-2,097	0	-4,590
Cooperative Water Program	-818	-151	0	0	-969	-126	-315	-387	-166	-994	0	-1,963
Water Resources Research Act Program	0	0	0	0	0	0	-1	0	0	-1	0	-1
TOTAL	-2,924	-538	0	0	-3,462	-699	-725	-1,107	-561	-3,092	0	-6,554

Details for DOI-Wide Changes a/
(Dollars in Thousands)

Activity/Subactivity/Program Element	Related Changes - Budget Restructures					DOI-Wide Management Efficiencies						
	Regional Executive Staff	Safety Staff	EROS Contract Support	Facilities Construct Sub-act	**Subtotal**	Travel Savings	Information Technology Savings	Acquisition Savings	Cost Cutting Efficiencies	**Subtotal**	**DOI WCF Adjustments**	**Total**
BIOLOGICAL RESEARCH												
Biological Research and Monitoring	-1,232	-70	0	0	-1,302	-346	-451	-515	-400	-1,712	0	-3,014
Biological Information Management & Delivery	-299	-17	0	0	-316	-66	-34	-96	-56	-252	0	-568
Cooperative Research Units	0	0	0	0	0	-31	-58	-32	-49	-170	0	-170
TOTAL	-1,531	-87	0	0	-1,618	-443	-543	-643	-505	-2,134	0	-3,752
ENTERPRISE INFORMATION												
Enterprise Information Security and Technology	0	0	0	0	0	-23	-40	-145	0	-208	-78	-286
Enterprise Information Resources	0	0	0	0	0	-19	-52	-118	-25	-214	32	-182
National Geospatial Program	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	-42	-92	-263	-25	-422	-46	-468
GLOBAL CHANGE	-239	0	0	0	-239	-122	-70	-114	-147	-453	0	-692
SCIENCE SUPPORT	7,475	995	284	0	8,754	-186	-174	-107	-101	-568	-27	8,159
FACILITIES												
Rental Payments and Operations & Maintenance	0	0	0	0	0	0	-25	-129	-1,300	-1,454	0	-1,454
Deferred Maintenance & Capital Improvement	0	0	0	-2,500	-2,500	0	0	-14	0	-14	0	-2,514
Construction	0	0	0	2,500	2,500	0	0	0	0	0	0	2,500
TOTAL	0	0	0	0	0	0	-25	-143	-1,300	-1,468	0	-1,468
TOTAL, SIR	**0**	**0**	**0**	**0**	**0**	**-2,331**	**-2,479**	**-3,571**	**-3,267**	**-11,648**	**-73**	**-11,721**

a/ For additional information related to the components of the DOI-Wide Changes, see the General Statement and other portions of Section G.

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Establishment of Construction Subactivity

	2009 Enacted	2010 Pres. Budget	2011 Base Budget	2011 Program Change
Facilities				
Construction	0	0	2,500	2,500
FTE	*0*	*0*	*0*	*0*
Deferred Maintenance and Capital Improvements	7,321	7,321	4,821	-2,500
FTE	*0*	*0*	*0*	*0*
Total Requirements	7,321	7,321	7,321	0
FTE	***0***	***0***	***0***	***0***

Construction Subactivity **+$2,500,000/0 FTE**

Deferred Maintenance and Capital Improvements **- $2,500,000/0 FTE**

A technical adjustment is proposed to move $2,500,000 from the Deferred Maintenance and Capital Improvements Subactivity to establish a new Construction Subactivity within the Facilities Activity.

The technical adjustment to establish a bureau-wide Construction subactivity provides USGS with a mechanism for budgeting and planning for needed facility construction. The establishment of the Construction subactivity provides USGS the capacity to modernize its real property assets and replace those that are in a state of disrepair, beyond their useful lives, or otherwise no longer cost-effective to operate. Establishment would provide recurring funding for asset replacement, including building design and construction, and capital improvements such as building system replacements. The plan provides for its much-needed improvements in building envelope (foundation, roof systems, facades, exterior doors, etc.) integrity.

Currently, the Operations and Maintenance Component (O&M), funding covers only the most basic recurring repairs and maintenance, and Deferred Maintenance and Capital Improvement (DMCI) subactivity funding in large part addresses only the most critical health and safety deficiencies. Through this prioritization process, the remediation of critical health and safety deficiencies repeatedly displaces less critical but important capital improvement investments. Consequently, opportunities to make astute investments are missed. Upgrades have high long-term payoff potential not only in reducing future costs but also in keeping the asset free from critical health and safety deficiencies that would impact personnel and operations, protecting building contents, and extending the asset's life.

The 2011 USGS Construction Fund plan embraces roof replacement projects under the banner of the bureau wide Building Envelope Integrity Program as the initial priority. Under the DMCI program, only failing roofs with leaks and other deficiencies so severe as to impact safety and health (causing mold growth, for example) or seriously threaten natural or cultural resources (for the USGS, damaging original satellite imagery records, for example) would warrant funding. Utilizing the Construction subactivity, the program bridges the void created by funding shortfalls

and supports a more sound investment philosophy toward maintenance as opposed to radiation.

Future efforts in Construction will allow for design and construction to replace existing structures and building systems. At the USGS, nine structures are in “poor” or “replace” condition and beyond their useful lives, with the largest of these having high Asset Priority Index (API) scores. Asset replacement through construction of a new building would provide the only reasonable and effective solution to support critical science and support activities. With the replacement of buildings with large deferred maintenance backlogs, estimated O&M costs could be reduced with the construction of a single, efficiently designed, state –of-the art office and laboratory facility.

Regional Executive Staff Technical Adjustment

	2009 Enacted	2010 Pres. Budget	Technical Adjustment (+/-)*	2011 Request
Geographic Research, Investigations, & Remote Sensing	596	1,152	-1,152	0
FTE	*4*	*7*	*-7*	*0*
Geologic Hazards, Resources, & Processes	1,930	1,999	-1,999	0
FTE	*12*	*12*	*-12*	*0*
Water Resources Investigations	3,346	3,462	-3,462	0
FTE	*21*	*21*	*-21*	*0*
Biological Research	1,572	1,618	-1,618	0
FTE	*10*	*10*	*-10*	*0*
Global Change	233	239	-239	0
FTE	*1*	*1*	*-1*	*0*
Enterprise Information *	526	0	0	0
FTE	*3*	*0*	*0*	*0*
Science Support	0	0	+8,470	8,470
FTE	*0*	*0*	*+51*	*51*
Total Requirements ($000)	**8,203**	**8,470**	**0**	**8,470**
FTE	***51***	***51***	***0***	***51***

* In 2010, the National Geospatial Program moved to Geography from Enterprise Information.

Geography **(-$1,152/-7 FTE)**

Geology **(-$1,999/-12 FTE)**

Water **(-$3,462/-21 FTE)**

Biology **(-$1,618/-10 FTE)**

Global Change **(-$239/-1 FTE)**

Science Support **(+$8,470/+51 FTE)**

A technical adjustment is proposed that would move $8,470,000 and 51 FTE from the Biology, Geography, Geology, Water and Global Change Activities to the Science Support Activity (salary, benefits and operating cost for the nine Regional Executives' staffs). Effective October 1, 2007, the USGS transitioned to an organizational structure in which the Regional Executives shifted from a single disciplinary focus in each region to a multidisciplinary focus in a geographic area. Regional Executives were realigned in order to provide oversight for all USGS organizations located within a geographic area of responsibility. This change was to encourage and facilitate integrated science within the bureau and foster partnerships to better accomplish

our mission. The regional realignment also affected the reporting of Regional Safety Officer positions and assigned roles and responsibilities. To sustain and continue to meet and exceed safety and healthy working conditions and promote a culture that recognizes and prevents workplace hazards, the adjustment is proposed to realign funds to better fit the new realignment model. Effective 2008, the Regional Executive staffs and Safety staff were no longer funded by a single discipline, instead funded by shared support from all USGS disciplines. This adjustment is proposed to realign the funds into one Activity.

There is no change to performance as a result of this proposed technical adjustment.

Earth Resources and Observation Center Technical Adjustment

	2010 President's Budget	Technical Adjustment (+/-)	2011 Request
Geographic Research, Investigations, and Remote Sensing			
Land Remote Sensing	284	-284	0
FTE	*5*	*-5*	*0*
Science Support	0	+284	+284
FTE	*0*	*+5*	*5*

Geography (-$284,000 / -5 FTE)

Science Support (+$284,000 / +5 FTE)

A technical adjustment is proposed to move $284,000 and five FTE from Geography to Science Support related to contract support provided to the Earth Resources and Observation Center. Effective fiscal year 2008, five contracting support personnel were realigned to the Office of Administrative Policy and Service (APS). This action resulted from Departmental requirements to have all contracting staff with increased warrant authority report directly to an individual in the GS-1102 contracting series. This series is located only in APS.

There is no change to performance as a result of this proposed technical adjustment.

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Science on the Landscape —

Regional and Crosscutting Activities

2011 Regional Activities

The USGS regional construct was developed to focus on issue-based, multidisciplinary science; align USGS work more closely with partners at the local and regional level; and enhance partnerships with Department of the Interior bureaus and other Federal, State, and local agencies. Closer proximity of the three USGS regions to Interior field bureaus, and field offices and other partners allows USGS scientists and managers to understand and address land and resource management issues at the local and regional levels, increases the opportunity for partnerships, and leverages resources. Regional efforts enhance the connection of the world-renowned capabilities of USGS with the high-priority, real-time land management, urban planning, and heightened security needs of local, Federal, State, Tribal, and community managers.

Regional geographic boundaries and main offices

Regional Overviews

Eastern Region

Overview — The Eastern Region (ER) has the longest urbanized coastline extending from the Gulf Coast of Mississippi to the Atlantic coastline of Maine, and along the Great Lakes from New York to Wisconsin; coastal issues are an important focus for USGS science in response to coastal storms, erosion, and other hazards. The Eastern Region is characterized by numerous, high-density, urban population centers located along or in close proximity to shorelines, hardwood forests, and the Appalachian Mountains. Continued expansion of coastal and riverine urban centers into rural areas of the region will impact the Nation's ability to use and enjoy natural resources while increasing the number and difficulty of the challenges to protect the welfare of citizens from natural disasters and other health risks.

The ER encompasses 26 States, District of Columbia, Puerto Rico, and the U.S. Virgin Islands; 24 percent (850,000 square miles) of U.S. land mass; 45 percent of Nation's coastline; 59 percent of U.S. population; and 57 out the 100 fastest growing counties.

The ER is comprised of three geographic areas, Midwest, Northeast, and Southeast. The Regional Director and 3 Regional Executives manage 37 offices dispersed to over 100 locations, 2,600 scientists and support staff, over 200 students, and nearly 100 contractor personnel.

Partnerships — Working with over 900 partners, USGS Eastern Region scientists help to contribute to partner priorities that align with USGS mission responsibilities in public health, energy and minerals use, and water and biological resources. The USGS Eastern Region works with the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), Office of Surface Mining (OSM) and Minerals Management Service (MMS) to help Interior's land, water, and resource management agencies understand environmental changes in the ecosystems they manage. In addition to the Interior bureaus, the Eastern Region partners with the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), the U.S. Army Corps of Engineers (USACE), the Department of Agriculture (USDA), the National Weather Service (NWS), Federal Emergency Management Agency (FEMA), numerous non-governmental agencies and universities and well as a number of tribes to understand the effects of climate change, to minimize the risks of hazards (both natural and man-made).

2010 Regional Priorities

Hydrologic Impacts due to Climate Change — The USGS and academic scientists working on the Southeast pilot project for the National Climate Change and Wildlife Science Center in the Apalachicola-Chattahoochee-Flint River Basin (ACF) in Georgia, Alabama, and Florida have developed prototype modeling tools to predict aquatic response to changes in stream flow. Downscaled climate projections, land use change, and hydrologic response were used to develop a hydrologic model that describes changes in natural flows, such as floods and droughts, and other hydrologic effects associated with land cover and climate change predictions. The hydrologic model is being coupled with an ecological model that allows the scientists and land managers in the ACF basin to estimate changes in viability and range of aquatic biota under alternative water-use, land-use and climate change scenarios. Sensitivity analyses are being conducted in 2010 to show areas of greatest scientific uncertainty in

predicting ecosystem responses to flow alteration, and peer-reviewed manuscripts are being prepared for all components of the study.

White-Nose Syndrome in Bats — Biologists estimate that since the winter of 2007, over one million hibernating, insect-eating bats from at least nine northeastern states have died as the result of a newly-emerged disease, white-nose syndrome (WNS). This disease represents an unprecedented threat to bats of the northeastern United States and potentially to cave-hibernating bat species of the world. Based on its current distribution, WNS threatens already endangered Indiana bats, Virginia big-eared bats, and associated ecosystems. In collaboration with other state and federal conservation agencies, the USGS-National Wildlife Health Center (NWHC) identified a new species of cold-loving fungus, *Geomyces destructans*, causative of the skin infection that is hallmark of WNS. Work continues on the development of an in situ hybridization assay for rapid detection of *G. destructans* in animal tissue. Preliminary data from WNS infection studies conducted at the NWHC suggest that *G. destructans* is transmitted from bat-to-bat. Additional infectivity studies are underway to continue to investigate mechanisms of *G. destructans* pathogenesis. Identification of *G. destructans* genetic material in environmental samples suggests that the fungus is present, and indicates the potential for fungus to be transmitted between bat hibernation caves as an unwanted hitch-hiker upon humans, their clothing, or caving gear.

Clinch-Powell Watershed — The USGS is working in the Clinch and Powell Rivers in Virginia and Tennessee to establish a scientific framework to understand the effects of increased energy demand, changes in land use, and changes in climatic variability on biodiversity on endangered populations of fresh-water mussels and other aquatic fauna. Continuous water-quality monitors, measuring specific conductivity, pH, temperature, and turbidity, were operated at Dungannon, VA, and Looney's Gap, TN in 2009. Four paired storm samples and two base flow samples were collected at both sites for a range of sediment, metal, nutrient, and organic constituents. Constituent concentrations at both sites were almost identical during large storm events, with concentrations of metals at least a magnitude of 10 higher than at base flow for both sites. Of particular interest, Dungannon, the upstream degraded mussel site, had higher concentrations of metals and major ions at base flow conditions. Continuous-monitor data for 2009 also showed higher concentrations in turbidity and specific conductance at Dungannon during low flow conditions. These initial results have lead to a stronger emphasis on a chronic stressor theory for mussel health degradation.

Mapping and Prediction of Flood Hazards — In January 2009 a Midwest Area Flood Science and Response Initiative Team was formed with members from USGS Water Science Centers in Indiana, Wisconsin, Ohio, Illinois, Michigan, Kentucky, and North Carolina; USGS Upper Mississippi Environmental Science Center; USGS regional and headquarters offices; FEMA Region 5, and the National Weather Service headquarters and regional offices. The team's focus issues include:

- hydrologic monitoring networks support for flood science;
- flood science resource rapid response;
- post-flood documentation studies;
- flood inundation mapping;
- flood risk communication; and
- flood science.

During 2009 the USGS Midwest Area Flood Science and Response team members worked with FEMA Region 5 staff on the development of a Memorandum of Understanding between the USGS Midwest Area and FEMA Region 5 to facilitate the creation, maintenance, and collection of geological, water and biological resources, geospatial, and remote sensing information needed to support natural hazard disaster planning, response, and recovery.
Midwest Area USGS offices produced, with other Federal, State, and local partners, advanced flood inundation mapping tools linked with USGS streamgage data and National Weather Service flood forecast points. Applications were implemented in Ohio, Indiana, and Illinois in 2009.

Natural Gas Development of the Marcellus Shale — The Marcellus Shale is a major unconventional natural gas play with a continuous subsurface extent across much of southern New York State, Northern and West Pennsylvania, West Virginia, and adjacent areas of Ohio and Maryland. Although prior studies by the USGS had highlighted substantial reserves of recoverable natural gas in this formation, recent spikes in energy prices and the use of new drilling and well development technologies have accelerated gas leasing and exploration across this several state area. A return of higher natural gas prices or production incentives could push development to the point that the Marcellus Shale becomes a major long-term source of domestic energy for the highly populated Mid-Atlantic and Northeastern US. The USGS is involved in better evaluating the Marcellus Shale as both source and reservoir of natural gas and is in communication with partners and cooperators with respect to approaches for monitoring and assessing the developing the resource with respect to possible threats to water, land, and aquatic resources. In 2010, the USGS coordinated efforts of energy companies, Federal and State agencies and River basin commissions to provide the data and information needed for the wise development of this vast new energy resource and to manage and protect the region's land, water, and aquatic resources in light of such development.

Central Region

Overview — The USGS Central Region (CR) scientists support land and resource management decision makers by engaging in a broad array of scientific investigations including agricultural practices, wildfire science, invasive species forecasting and control, surface and ground water availability, carbon and alternative energy development, ecosystem-based landscape management and hazard mitigation. These investigations gather data and integrate information supporting development of predictive models and other land and resource management methods and techniques. Within this ecologically diverse Region, consisting of the 15 states between the Mississippi River and the western slope of the Rocky Mountains, are vast tracks of federally managed land rich with energy, timber and recreational resources; iconic national parks including Yellowstone, Rocky Mountain and Big Bend; critical water resources such as the headwaters of the Rio Grande, Colorado and Missouri Rivers, Denver Basin and Ogallala aquifer; and fragile ecosystems stressed by changes in land use or climate such as Mississippi River Delta, Green River Basin and the Nebraska Sand Hills. In addition to being a major source of food production, the region has the potential to be a key component in the nation’s quest for energy independence with potentially rich sources of alternative energy including solar, wind and bio-fuels as well as large reserves of carbon-based fuels. Broad open spaces and rural landscapes surround urban corridors which have experienced rapid growth in the last two decades. The CR has 27 Science Centers with 2,700 employees and 975 on-site contractors; 74 USGS Offices located in 88 cities and 21 field offices; the Regional Denver office; The National Earthquake Information Center; The Earth Resources Observation Science Center; The National Water Quality Laboratory; and The U.S. National Ice Core Laboratory.

The CR consists of three geographic areas, North Central, Rocky Mountain, and South Central.

Partnerships — The CR has built partnerships with federal, state and local agencies and tribal governments, universities, non-governmental and international organizations, the private sector, and the military services including the U.S. Army Corps of Engineers. The CR is the primary USGS liaison with U.S. Northern Command (NORTHCOM) and North American Aerospace Defense Command (NORAD). Two full-time liaisons coordinate USGS's collaboration with NORTHCOM and NORAD contingency response.

2010 Regional Priorities

Upper Midwest/ Northern Plains 2009 Spring Floods — In the spring of 2009, severe flooding occurred in the Missouri River and Red River of the North Basins in North Dakota, western Minnesota, and northeastern South Dakota. As this unprecedented flood evolved in scale and magnitude, USGS Water Science Centers for North Dakota and Minnesota with assistance from personnel from Montana, Nebraska, Kansas, Iowa, Illinois, and Florida provided more than 1,200 stream flow measurements within a six-week period. The USGS provided data and real-time flood information to NWS and other offices for immediate use in flood forecasting; state and local emergency managers relied on USGS data to estimate flood dangers to help protect lives and property; USGS installed rapid deployment gages and used acoustic Doppler technology to help USACE, BOR, NWS, state, and local agencies improve flood forecasts, manage associated flood controls at dams, assess the erosive action of water at levees, and provide timely warnings to the public.

American Samoa Earthquake and Tsunami Response — Following the magnitude 8 earthquake which struck 120 miles southwest of the islands of Samoa, American Samoa and Tonga and the ensuing tsunami, a team of scientists deployed to the region with an array of five seismometers to capture ground motion from the aftershocks and participated in tsunami inundation mapping on American Samoa. The aftershock ground motion data is critical to advance knowledge on how seismic energy propagates locally and regionally and improve seismic hazard maps for Guam and American Samoa. Information from seismic hazard maps informs local building codes, earthquake response planning and hazard mitigation efforts in the region. These new products will be delivered in 2011.

Endocrine Disrupters and Intersex Fish — Columbia Environmental Research Center scientists completed and published the first comprehensive U.S. survey of intersex in fish. Intersex has been a public concern due to linkages of this condition to the release of endocrine disrupting chemicals into the environment and particularly into the water supply. Intersex is an abnormal condition of fish characterized by individual fish having both male and female gonad tissues. Intersex conditions were found in approximately one-third of the sites monitored; much greater than anticipated. Previously, only isolated reports of this condition existed. On-going studies will examine environmental (i.e. temperature) and chemical factors that cause this condition; the development of diagnostic tools; and the study population-level impacts of intersex in fish.

Forecast Mekong — Officials from the USGS were invited by the State Department to participate in a ministerial event with South East Asian nations to provide an overview of the Delta Research and Global Observation Network which was initiated by the USGS in 2007 to promote a community of practice among river mega-delta scientists and resource managers to share expertise. As a result, the State Department and USGS entered an agreement to develop

"Forecast Mekong", an interactive data integration, modeling, and visualization system. When fully developed by the USGS, in partnership with local governments and universities throughout the Mekong region, the Forecast Mekong program will provide a valuable planning tool to visualize the consequences of climate change and river management. This will establish a framework to provide further support to the Mekong River Commission and the Mississippi River Commission "sister river" partnership to share expertise and best practices in areas such as climate change adaptation; flood and drought management; hydropower and impact assessment, water demand and food security; and water resource management.

Platte River Ecosystems — The Central Platte River provides essential habitat for the Central Flyway and supports the annual migration of over one-half million sandhill cranes, several million waterfowl, and for endangered species such as the whooping crane, piping plover and least tern. Changes in water and land use have transformed the river channel, altered the structure of riparian habitats and allowed for the introduction and spread of invasive species. In 2006, the Department and states of Colorado, Nebraska and Wyoming signed a recovery plan for the Platte River to improve habitat for endangered species. The USGS collaborates with state, federal and local partners to develop successful adaptive management strategies and the USGS research is being used to guide the development of a new five-year management plan for the crane population. In 2010 and 2011, the USGS will design research and monitoring protocols for the Platte River Recovery Implementation Program and is continuing to operate hydrologic monitoring stations along the river, monitor cranes and other migratory waterfowl, expand technological studies to better link surface and ground water levels and investigate the effects of invasive species. The USGS is studying least tern and piping plover nesting habitat in the sandpits and sandbars of the Platte River.

Sustainable Energy Development — The USGS provides scientific data collection and monitoring, analysis, modeling and data integration to partners in the Wyoming Landscape Conservation Initiative which includes other Department bureaus, state and local agencies, industry and private land owners committed to maintaining healthy landscapes and water supplies, sustaining wildlife and preserving recreational and grazing uses while developing natural gas energy in the Green River Basin. This information helps guide decisions on energy infrastructure design and placement to minimize habitat disturbance, maintaining wildlife corridors and post development habitat restoration. Range maps for 152 of Wyoming's land animals, including species of concern, have been developed. A comparison of long-term salinity trends was conducted to evaluate impact on water quality. Models have been developed for assessing vegetation type, distribution and disturbance animal habitats, songbird nesting success, surface geology and mineral and oil and gas resources. More than 65 habitat improvement projects have been initiated. A web-based site for sharing and displaying products was developed and is in use. In 2011, the USGS will conduct an Integrated Assessment compiling and integrating lessons learned and scientific data to develop a tool for predicting cumulative effects of land-use changes for prioritizing habitat improvement projects. Groundwater monitoring will be done at up to 60 sites, three stream gages will be operated, a water-level monitoring well will be instrumented and a sediment transport study will be initiated. Additionally, effectiveness monitoring approaches will be used to provide more scientifically based information for land management decision making and adaptive management applications.

Climate Impacts on the Upper Colorado River Basin — The primary source of the water in the Colorado River and its tributaries is from snow melt in the mountainous regions of the Upper Basin states, whereas the largest demand for water is from agriculture and cities in the Lower Basin states. With this backdrop, climate change impacts on Upper Colorado River Basin

(UCRB) water supply will have ecological, societal, and economic consequences across the western United States. The USGS is partnering with the BOR, the USACE, FWS, NPS, USFS, and NOAA to identify science required to support resource management decisions. The USGS is working with the National Ecological Observatory Network (NEON) to develop landscape and ecological forecasting models and render technical assistance to their groundwater monitoring network development. A management steering committee was established to help guide planning for future studies. A multidisciplinary science team was established and tasked to develop a science plan that will identify the needs of the various stakeholder groups with interested in the effects of climate change on the water supply and ecosystems within the UCRB watershed. A website is being developed that will contain both static data layers and links to dynamic layers covering the Upper Colorado River Basin such that users can manipulate and overlay data layers. The USGS planning efforts will be expanded to incorporate the broad stakeholder community and scientists to develop the science plan for Climate Effects Network the UCRB. A workshop is planned for 2010 that will bring together representative scientists from the USGS, universities, and the stakeholder community to develop the plan.

Ozarks Karst and Ecosystem Services — Karst topography, created by water carving underground channels and caves in porous rock creates land use challenges because the same forces that produce caves and caverns make the land prone to sinkholes, subsidence and water contamination. It is estimated that Karst landscape makes up 25 percent of the U.S. surface area. During 2009, data collection on topographic, geologic, and geochemical data in northern Arkansas continued. The orientation of structural and topographic features were studied and an innovative approach to classifying karst regions in Missouri using characteristic features of the landscape such as the occurrence of springs, caves, sinkholes, and voids recorded in well logs was developed. Two study sites were established in Buffalo National River, Mill Creek and Davis Creek watersheds. An extensive field-based inventory of springs and sinkholes was completed. Land cover data within each basin was evaluated to determine the influence of agricultural land cover and land use on water quality. Using high-resolution Light Detection and Ranging (LIDAR) data of the Mill Creek watershed study site, a preliminary analysis of joint orientation was accomplished. Data gathered will be used to analyses resilience of hydrologic ecosystem services in five watersheds in the Ozark highlands of Missouri and Arkansas. This will be accomplished by relating measures of ecosystem services, such as water quality, to measures of stressors, such as hazardous waste spills and climate, and, more importantly, the rate of change of the stressors.

Western Region

Overview — Western landscapes include the nation's driest and wettest places, highest and lowest, warmest and coldest, and the highly urbanized and remote. The West encompasses the majority of US public lands with their own unique and often competing management pressures, tropical Pacific Islands, agricultural regions entirely reliant on irrigation, the nation's highest incidence of wildfires, vast regions of minimally explored terrains both above and below sea-level, and significant untapped potential for development of mineral resources, sustainable energy, and carbon sequestration.

Superimposed on the West's diverse natural features is a human population of more than 50 million people, and some of the nation's most rapidly growing communities. People are particularly attracted to coastal zones, the "public land states", and the arid Southwest, and much of this growth is occurring in areas where water supplies are limited and often over-allocated. Many of these fast-growing regions are also the Nation's most vulnerable to risks from volcano, earthquake, tsunami, landslide, flooding, and wildfire hazards. Finally, global

climate change poses particularly severe implications for the future of ecosystems, communities, and infrastructure throughout the West.

In response to the key driving forces in the West, the USGS has developed strong and diverse science capacity for both interdisciplinary and discipline-based research. The Region hosts approximately 2,500 USGS employees located in 22 major science centers and 60 field locations. This includes unique volcano observatories in Hawaii, Alaska, California, and Washington; and the USGS Earthquake Hazard Program, the world's premiere earthquake science team.

The Western Region is comprised of 3 "geographic areas", Northwest, Pacific Southwest, and Alaska.

Partnerships — USGS Western Region has longstanding relationships with numerous Federal agencies such as USFS, USACE, EPA, NASA, Department of Energy (DOE) and Department of Defense (DOD). The USGS also has strong partnerships with numerous Tribes, State and local governments, and major private partners such as Bonneville Power Authority, Western Area Power Authority, and others who manage hundreds of irrigation and power districts in the arid West. In addition, like the rest of the USGS, Western Region delivers objective, credible science and technical support to all of Interior's bureaus, with especially strong partnerships with the NPS, BOR, BLM, and FWS.

2010 Regional Priorities

Multi-Hazards Disaster Scenarios: ARkStorm — The USGS Multi-Hazards Demonstration Project (MHDP) is working with partners to increase community resiliency to natural disasters by integrating earth science in urban areas with economic analysis and emergency response. A principle activity is the development of science-based disaster scenarios to inform decision makers. Following the successful MHDP-based ShakeOut earthquake scenario of 2008, ARkStorm takes a similar approach in proposing and assessing a large winter storm scenario. The ARkStorm scenario hypothesizes severe storms that entrain huge amounts of moisture from the tropical Pacific and dump it on California over a several week period. To accomplish the task the MHDP team assembled experts from the NOAA, the USGS, Scripps Institute of Oceanography, the State of California, California Geological Survey, the University of Colorado, the National Center for Atmospheric Research, FEMA, and many other organizations to design the scenario. The ARkStorm atmospherics team completed a state of the art, scientifically credible meteorological model from records of past storms. ARkStorm is using FEMA's new digital flood rate insurance maps (dFIRMS) as a representation of areas vulnerable to flooding. With these secondary hazards, expert panels have met to examine the physical, environmental, and agricultural damages and lifeline service outages. The ARkStorm economics team has constructed a computable general equilibrium model of the California Economy in preparation for the analysis of economic impacts from these damages and outages. This ARkStorm scenario will serve as the basis of the California statewide Golden Guardian emergency response drill scheduled to occur in May 2011, to improve future hazards planning and response.

Alaska Native Health and Ecosystem Studies — The USGS is working closely with a number of Federal, State, and local native organizations in assessing the potential interconnections between naturally occurring minerals, ecosystem health, wildlife health, and human health. Water quality and contaminant data from the USGS is used to by the Alaska Native Tribal Health Consortium to better understand how climate change, Alaska's heavily mineralized

environment (e.g. mercury, asbestos, arsenic), and wildlife movement patterns will relate to subsistence food safety and key health changes. The USGS also established an Alaska Interagency Ecosystem Health Work Group to bring together and leverage the significant and diverse missions, skills, and capacities of the participants to gain a greater understanding of the relationships between ecosystems and human health. Membership includes the Alaska Native Tribal Health Consortium, Alaska Departments of Environmental Conservation and Fish and Game, Alaska Division of Public Health, Centers for Disease Control and Prevention (CDC), FWS, and EPA. The USGS and the working group will continue to establish baselines for hazards (contaminants and environmental), identify pathways and sentinels and study to determine effects; and determine important data sets and mechanisms for exchange.

Developing New Tools for River Management: River Ecosystem and Modeling Science (REMS) — Competing demands for water supplies is one of the most challenging problems facing natural resource managers in the West. New streamflow and habitat prediction models are needed to assist managers in the face of increasing complexity and uncertainty in water management decisionmaking. Managers need to have tools available to help assess the implications of possible management options on streamflow, habitat, and biological populations and to incorporate ecosystem-level understanding into management of watersheds. Toward that end, the USGS has launched a REMS pilot project in the Klamath River. The ultimate goal of the REMS effort is to advance the science and develop the next generation of tools needed to understand the hydrologic conditions necessary to support instream habitat requirements for river ecosystems. As a first step toward the larger goals, the Klamath pilot focuses on describing the ‘environmental flows’ and temperatures required to benefit the salmon run in this relatively large river basin. The Klamath Basin is the ideal location for this pilot project because it represents many of the water availability issues of concern across the Nation. Klamath is home to salmon, agriculture, dams, Tribal interests, and is already a scientific and management priority with ongoing modeling and process studies related to surface water, ground water, and biology. Over the past decade, USGS science has played a key role in helping resolve water and other resource management challenges in the Klamath, and the REMS project will provide additional knowledge and tools that will be directly applicable to these issues.

Great Basin Multidisciplinary Information for Adaptive Management — The Great Basin and Sagebrush Biome encompass over 120 million acres of semi-arid lands across five Western States; it is the largest semi-arid ecosystem in the West and more than 70% of the Great Basin is in the public domain, managed primarily by Department of the Interior Bureaus. Primary stressors include multiple land uses, invasion of exotic plants, competition for water, soil erosion, altered fire regimes and wildlife disease. USGS scientists are actively engaged in interdisciplinary, high priority research and monitoring efforts in the Great Basin sagebrush habitats, developing forecasting models to demonstrate how land-use and climate features influence a diversity of ecosystem services (carbon sequestration, waterfowl habitat, amphibian habitat, agricultural pollination, floristic quality, nutrient retention, and others); delineating hydrologic functions and geochemical characteristics of rivers, streams, springs and wetlands; and, analyzing and demonstrating landscape-scale adaptive management effectiveness, impacts, and cost-benefits (e.g., Land Treatment Digital Library). Natural resource managers are being compelled to work more and more frequently under complex ecological conditions to curb and/or manage for these impacts, under the rubric of growing demands for public services. Sustaining the Great Basin ecosystems and their associated resources for multiple uses requires strong collaborative partnerships among research and management organizations in the region.

The North Slope: Energy, Natural Resources, and Climate Change — Alaska's North Slope is at the confluence of our Nation's oil and gas potential and the DOI's natural resource stewardship, all played out on a shifting, disappearing landscape driven by one of the greatest expressions of global climate change in modern history. USGS science tells us that this region's undiscovered oil potential is not only the greatest in the Nation, but in the world's circumpolar Arctic. Here too, the DOI manages some 57 million acres that are critical for continental and international populations of birds; essential habitats for iconic arctic species such as the polar bear; and the homes of Native Alaskans that depend on living natural resources for subsistence. These lake, island, and coastal lagoon dominated landscapes are being altered by rapid and accelerating rates of coastal erosion driven in large part by reduced sea ice—sea ice that no longer protects sensitive and warming permafrost-structured coasts during the severe fall storm season. In this changing environment, resource management decisions such as permitting the next suite of 50-year oil leases cannot effectively be informed by past experience; rather, decisions must be based on future altered landscapes. The USGS has developed forecasts based on an integrated understanding of erosional processes, structural geology, and wildlife response to coastal vegetation and water changes. Forward looking science from the USGS is increasingly critical to guide DOI in its duel mission of energy development and resource protection.

Science to Protect and Restore Puget Sound — With more than 1,000 miles of coastline and draining more than 13,700 square miles of Washington State, Puget Sound is the Nation's second largest estuary after Chesapeake Bay. USGS land cover trends show that the Puget lowlands have been affected by both rapid deforestation and urbanization. Human activities have impaired water quality and adversely impacted populations of Northwest icons such as salmon and orca whales. The USGS is playing a critical role in providing science to better protect and restore Puget Sound, with active, long-term research on endangered salmon runs, water quality, sediment loading, and flood hazards. In addition, the USGS Coastal Habitats in Puget Sound (CHIPS) Program evaluates the effects of coastal development and examines the ecosystem response to large scale restoration projects, including removal of the Elwha River dams and restoration of the Skagit and Nisqually deltas. The USGS is developing a model to describe structure and function of the Puget Sound ecosystem that will be used to identify monitoring needs, measure and evaluate indicators of landscape level change in and around the Sound and inform management practices and decision-making.

Department Crosscuts

As the Department's science bureau, the USGS conducts research that is foundational to numerous intradepartmental and interagency crosscutting activities. These crosscutting activities range from environmental issues such as the Everglades restoration and coral reef protection in the Pacific Islands to environmental and climactic change issues being studied under the Global Change rubric. The following are crosscutting activities in which the USGS contributes.

(Dollars in Millions)

	2008 Enacted	2009 Enacted	2010 Enacted	2011 President's Request
Great Lakes Restoration*	15.9	17.2	32.2	26.3
Coral Reef Protection	4.3	4.3	4.6	4.6
Greater Everglades Ecosystem Restoration	6.9	6.8	6.9	6.9
Chesapeake Bay	5.2	5.2	4.8	8.4
Columbia River Basin	9.1	9.6	11.9	8.9

Klamath River Basin	2.8	2.8	2.8	2.6
San Francisco Bay Science	6.95	6.35	7.21	7.21
Coastal Ecosystem (Pacific Coast)	3.06	3.75	3.85	4.23
Arctic Ecosystems	0	0	4.2	4.2

*2010 and 2011 figure includes reimbursable funding form EPA.

Great Lakes Restoration — In 2010, the USGS received over $18.0 million in funding from the EPA to conduct science for Great Lakes restoration in collaboration with other federal agencies and stakeholders. The USGS Midwest Area is integrating USGS science, monitoring, and modeling efforts to create a partner-driven strategic science framework for managing the Great Lakes and meeting Great Lakes Restoration Initiative goals and objectives. Building on this science framework, a comprehensive suite of carefully planned research projects have been designed that center on the five GLRI focus areas (Invasive Species; Habitat and Wildlife Protection and Restoration; Nearshore Health and Nonpoint Source; Toxic Substances and Areas of Concern; and Accountability, Monitoring, Evaluation, Communication, and Partnerships). The results of these projects will provide new science, information, and tools for managers and stakeholders to protect and restore the chemical, physical, and biological integrity of the Great Lakes Basin ecosystem.

Coral Reef Protection — Coral reefs worldwide are in decline from stressors such as climate change, land-based sources of pollution and unsustainable fishing practices. The Department of the Interior alone has responsibility for more than 3.5 million acres of submerged habitat. USGS research on reef biodiversity, biogeochemical processes, food webs and coral health are designed to enable managers to understand and deal with the effects of rising seawater temperatures, ocean acidification, disease and other impacts. In addition to shallow coral habitat, the USGS is providing information to MMS on the structure, diversity, extent and susceptibility of deep coral habitat in the Gulf of Mexico to oil and gas exploration . Resource managers with the NPS, FWS, MMS, NOAA, and coastal States call upon the USGS to help them understand the causes and consequences of the reef decline of shallow corals and to provide ecosystem dynamics of deep coral communities so that local scale stressors can be reduced or eliminated and the recovery and resilience of coral encouraged to maintain sustainable reefs against the impacts of climate change. The USGS coordinates with the Coral Reef Task Force and its member States and Territories to inform Local Action Strategies about impacts to coral reefs and methods to sustain and restore coral reef resources in State, Territorial and Federal waters.

In 2010, USGS research and information delivery on shallow coral ecosystems will encompass: The role, function and performance of “no-take” coral reef reserves relative to non-reserve areas; connectivity among reefs and between adjacent mangrove and seagrass habitats; impacts to reefs from land-based sediments, pollutants and atmospheric dust; effects of changing ocean temperatures and pH on keystone species; reef history from paleoecological studies; and coral disease processes and their relation to human disturbances. In addition, research collaborations in the Gulf of Mexico and Atlantic with MMS, NOAA and universities will describe the nature, extent, ecology and vulnerability of deep coral habitats. The dissemination of information, specific to coral management issues, will be achieved via planned peer-reviewed publications, presentations at conferences, and through meetings and workshops with our partners and stakeholders.

Restoring the Nation's Greater Everglades and Coastal Ecosystems — USGS’s science focuses on developing a basic understanding of the Greater Everglades ecosystems through research and monitoring, then developing predictive ecosystem models. By using the Greater Everglades as a ‘living laboratory of change’ the USGS is advancing the ‘science of

understanding and predicting *change*' as we are facing tomorrow's challenges. To help generate a fundamental understanding of Everglades ecosystems, USGS's research and monitoring has and continues to focus on ecosystem history, water quality and contaminants, surface and groundwater flows, and species response to hydropattern dynamics.

Chesapeake Bay Restoration and Protection — President Obama issued an E.O. in May, 2009 to have the federal government lead efforts to restore and protect the Chesapeake Bay, the Nation's largest estuary. The EO calls for a new restoration strategy by May, 2010 and for the USGS and NOAA to co-lead federal activities to "Coordinate Tools and Science for Strategic Decision Making" The proposed science activities would support the major goals of the draft E.O. strategy:

- Restore Clean Water
- Conserve Treasured Places and Restore Habitats, Fish, and Wildlife
- Adapt for Climate Change

The USGS, as the science agency of the Department of the Interior is working with other federal agencies (NOAA, EPA, FWS, NPS, and USACE) to identify activities needed to address the highest priorities of the E.O., including the impacts of climate change. As described in the November 9, 2009 Draft Strategy, the USGS and NOAA will engage and assist state, local and private partners in a collective effort to respond to the impacts of a changing climate in the Chesapeake Bay and watershed. For 2011, the President's budget calls for the USGS, working with NOAA to build a concerted effort to coordinate climate change science and adaptation guidance throughout the watershed, and to coordinate the watershed effort with emerging networks of regional climate services.

An additional $3.6 million of funding in 2011 would be used to address several components of watershed assessments for climate change including:

- Improve the USGS Chesapeake Bay Land-Change Model, and use it to simulate the combined effects from alternative future climate and land use scenarios. The forecasts will be further used to assess potential changes to forests and stream habitats in the Bay watershed and nutrient and sediment loads to the Bay. The USGS will identify the most vulnerable areas in the watershed and interact with FWS, NPS, and USDA to develop adaptive strategies. The USGS will also work with FWS to assess impacts on key fish and wildlife and with EPA to assess potential changes in nutrient and sediment loads.
- Conduct limited sampling of baseline conditions in selected watersheds to begin to assess impacts of climate and land change.
- Construct web-based decision-support applications to help DOI and other resource managers visualize future scenarios and prioritize areas for adaptation to climate and land-use change. The application would be part of the Chesapeake Online Adaptive Support Toolbox (COAST) that is described in the Tools and Science Initiative.
- Establish decision-support specialists to synthesize science to support management decisions and interact with DOI and other decision-makers on adaptive polices for climate and land change. The specialists would be part of the interagency climate team and would interact with the proposed DOI Chesapeake Landscape Conservation Cooperative(s).

Improving the USGS Chesapeake Land-Change model will meet the critical need to address changes in urban, agricultural, and forested lands. The initial land-change model, which is supported by existing funds, is only focused on predicting change in urban areas.

Science for the Northwest's Dominant River System — The Columbia River Basin
The Columbia River system, in all its constituent parts -- streams, rivers, lakes, precipitation regimes, glaciers and snowmelt -- is at the core of the Columbia Basin's environment, culture, and economy. Covering nearly 260,000 square miles, the Basin drains hundreds of smaller rivers and tributaries and is essential habitat for numerous important aquatic and terrestrial game and trust species. To date, urbanization, recreation, commercial fisheries, hydropower and agriculture have had marked impacts on the basin's aquatic habitat and fish populations. Multiple USGS Science Centers across the nation have scientists representing all scientific disciplines actively engaged in Columbia River Basin studies, making critical contributions to resolving challenges facing those who live in and have land and water management responsibilities for the Columbia River Basin. USGS scientists are contributing data and expertise to ecosystem restoration efforts for key fish species (steelhead, salmon & sturgeon); examining the presence of endocrine disrupting emerging contaminants (pharmaceuticals, personal care products and anthropogenic waste) in streambed sediments, fish and other aquatic organisms; adjusting watershed models to account for climate change and the effects of potential future warming on runoff upon dam operations; developing an invasive species research program to provide early detection and potential treatment methods to address the effects on native fish stocks and habitat restoration efforts; and collecting and analyzing water quality and availability data through the National Water-Quality Assessment (NAWQA) Program.

The USGS also leads and actively participates in a significant number of collaborative ecosystem-based partnership efforts, working side-by-side with an array of federal, state, tribal and non-governmental entities, each charged with different missions, trust responsibilities, yet all committed to improving the health of the natural resources in the Basin. For example, USGS executives and science staff are part of the Columbia River Basin Federal Caucus, a collaborative effort consisting of nine Federal agencies with resource and science responsibilities in the Basin. The Caucus is working to better organize, coordinate and integrate needs for Federally listed fish recovery in the Columbia River Basin. In addition, USGS employees play a leadership role in the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), a forum for coordinating state, federal, and tribal aquatic habitat and salmonid monitoring programs.

Klamath River Basin — Historically, in the Klamath River Basin of south-central Oregon and northwestern California, there have been serious and litigious conflicts over severe water-related matters, with multiple stakeholders from agriculture, ranching, logging, natural resource conservation, tribes, and recreational and commercial fishing interests. Recently, forward-thinking efforts have charted a new path based on collaborative solutions to environmental and economic problems, using best science data and practices.

The USGS has a large science presence in the Klamath Basin; our research provides a broad, defensible foundation for management decisions and actions regarding endangered fish population dynamics and ecosystem health, water quality impacts on salmon recovery, and modeling and forecasting seasonal run-off and other water dynamics. Recent USGS science has primarily focused on the key information needs of Reclamation and the FWS on issues related to Endangered Species Act consultation, tribal trust, and water availability. The USGS work in hydrology of the Klamath Basin serves as the lynchpin for ongoing ground-water modeling and efforts to develop a reliable quantitative tool for optimally managing seasonal use

of water in the upper basin and stream flows in the lower Klamath River. Beyond providing key information for managers and stakeholders and future resource allocations in the basin, USGS data is also used in integrated studies to understand and predict endangered fish survival and migration behaviors in response to changing environmental conditions. In addition, the Secretary of the Interior appointed a USGS scientist and Science Center Director to lead the science planning associated with the Secretarial Determination for the possible removal of four dams on the Klamath River. The lessons learned from the Klamath River can help shape future dam removal and river restoration activities throughout the Northwest.

San Francisco Bay Science — The San Francisco Bay-Delta ecosystem is recognized as one of the world's threatened hotspots for biodiversity, supporting unique native species and their critical tidal wetland habitats. Like other urban estuaries, this system has a history of anthropogenic changes that have degraded the ecosystem. For example, half of the estuary's historic freshwater flow is exported sewage from over two million people, and chemical and biological (exotic species) contaminants are discharged each day into the system, so that less than 10 percent of its original tidal wetland and riparian habitats remain. However, the San Francisco estuary is now the subject of aggressive and expensive restoration efforts. As one example, in the past decade, federal, state, and non-governmental organization partnerships have purchased nearly 10,000 hectares of former salt evaporation ponds for restoration. An interdisciplinary USGS team is working to provide a comprehensive assessment of the ecology of the salt ponds, baylands, and linked shallow water wetlands, so that optimal restoration and management strategies can be exercised. Other on-going research is helping to predict how wetlands will be affected by anticipated future climate changes. The USGS is also conducting studies to understand and predict how water quality and quality within San Francisco Bay will be affected by the interaction of current stressors with future changes such as population growth and climate change. These and other studies supply scientific guidance to current and future resource and restoration managers.

Coastal Ecosystem Responses to Influences from Land and Sea — Nearshore marine ecosystems on the Pacific Coast face unprecedented challenges at local to regional scales, with threats arising from both the watersheds that drain into nearshore environments, and the adjoining land/ocean interfaces. From the nearby watersheds, challenges include elevated biological and chemical pollutants associated with increasing human populations along coastlines and associated consequences of climate change modifications to the hydrological processes responsible for transporting pollutants, nutrients, and sediments that ultimately deposit into nearshore environments. While our understanding of the physical processes of watershed discharging to nearshore environments is fairly well known, the potential effects of climate change, sea level rise, and ocean acidification are less well known, and the implications for biological systems are only beginning to be explored.

To enhance the Nation's knowledge of current and potential threats to the health of nearshore ecosystems of the northeastern Pacific Ocean, the USGS initiated a multi-Center, multi-agency study that examines the gradients of human influence on Pacific coast nearshore environments and associated onshore watersheds as measured through the keystone species the sea otter and its food web. The study examines differences in nearshore ocean primary productivity, diet and nutrition of otters and their prey, and the application of gene expression technology that may show how biological communities respond on a micro-biological level to different classes of environmental toxicants. The study involves three USGS Science Centers located across the Pacific coast as well as the MMS, NPS, FWS, Exxon Valdez Oil Spill Trustee Council, (EVOS), the North Pacific Research Board (NPRB) and the Monterey Bay Aquarium. This cooperative partnership enhances the ability to assess of the health of nearshore ecosystems in six eastern

Pacific nearshore environments, extending from southern California to southwest Alaska, an area that serves as a large-scale laboratory incorporating the range of human densities and impacts in watersheds and inputs from the oceanic realm across this large latitudinal gradient.

In 2010, the USGS developed collaborations with tribal, local, state and federal agencies in Washington and the Canadian Province of British Columbia and began the collection of watershed characteristics and nearshore sea otter forage data. In 2011, the USGS will continue field sampling that will also include sea otter diet and energetic data, along with sea otter gene expression to environmental toxicants and growth rate information.

Changing Arctic Ecosystems — In 2010 the USGS received an increase of $4.2 million to conduct research in the Arctic to support the conservation of the nation's Arctic ecosystems and the unique fish, wildlife, and plants they support. The Department of the Interior plays a major stewardship role for both resource development and conservation through the Minerals Management Service's Outer Continental Shelf Program, Bureau of Land Management's National Petroleum Reserve-Alaska, and the Arctic and sub-Arctic National Wildlife Refuges and National Parks of the FWS and NPS. In 2010, the USGS developed statements of work and detailed study plans for a suite of projects related to 1) documenting how climate, ecosystem processes and species' life histories have already changed; and 2) developing, testing and validating models related to forecasting the effects of climate change on sea ice and tundra ecosystems and some of the species these ecosystems support such as polar bears, Pacific walrus, Pacific black brant and yellow-billed loons. A variety of projects were initiated in cooperation with other Interior agencies, universities and the USGS science centers. The information derived from these studies will assist Interior agencies with the management and conservation of natural resources in a region of rapidly changing landscapes.

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Geographic Research, Investigations, and Remote Sensing

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Land Remote Sensing ($000)	61,718	0	63,707	-1,195	+13,350	75,862	+12,155
FTE	*142*	*0*	*146*	*-8*	*+3*	*141*	*-5*
Geographic Analysis and Monitoring ($000)	10,598	0	11,135	-192	+750	11,693	+558
FTE	*66*	*0*	*66*	-1	0	66	-1
National Geospatial Program [4]	0	0	70,748	-1,361	-3,500	65,887	-4,861
FTE	*0*	0	*330*	*-3*	*-4*	*323*	*-7*
Total Requirements ($000)	**72,316**	**0**	**145,590**	**-2,748**	**+10,600**	**153,442**	**+7,852**
Total FTE	***208***	***0***	***542***	***-12***	***-1***	***529***	***-13***

1) $1,304 in fixed costs is absorbed ($278 in Land Remote Sensing, $186 in Geographic Analysis and Monitoring and $840 in National Geospatial Program).

2) See the General Statement and Section G for Details on DOI-wide Changes.

3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

4) In 2010 the National Geospatial Program moved to Geography from Enterprise Information

Activity Summary

The 2011 budget request for the Geographic Research, Investigations, and Remote Sensing Activity (Geography) is $153,442,000 and 529 FTE, a net program change of +$10,600,000 and -1 FTE from the 2010 Enacted level. Additional information on program changes is provided in each subactivity section and in the Secretarial Initiatives and Mission Increase section beginning on page E-1.

Geography seeks to understand the world - its human and physical features - through an understanding of place, location, spatial and temporal relationships, and regional dynamics. Geographers study where things are and how they got there. It is the bridge between the human and physical sciences, with a focus on understanding the relationship between human activities and landscape change. It looks at the spatial connection between people, places, and the earth. Geographic science integrates important environmental and societal processes to facilitate understanding of how human well-being and environmental quality can be improved and maintained.

Geography works toward becoming a global leader in the science of:

- Integrated vulnerability and risk assessment that incorporate the natural, social, and economic sciences,
- Scenario-based, alternative futures tools to reduce environmental and hazard risks and to facilitate adaptation to an ever-changing world at landscape scales,
- Land observations and monitoring via remote sensing, and
- Maintaining the USGS' role as the civilian mapping agency for the Federal government.

The U.S. Geological Survey (USGS) confronts some of the most pressing natural resource and environmental issues facing the Nation, such as energy development, climate change, hazards, and resource management. Observing the Earth with remote sensing satellites, USGS geographers monitor and analyze changes on the land, study connections between people and the land, and provide society with relevant science information to inform public decisions. The surface of the Earth is changing rapidly, at local, regional, national, even global scales, with

The USGS Geography Activity is uniquely suited for modeling land change, given its diverse expertise set and ability to analyze and integrate both biophysical and socioeconomic processes affecting landscape change. Geography is developing a framework for modeling land change across regional and continental extents, constructing multiple scenario-based models at these scales, and applying the models to answer key scientific questions including the potential effects of land-use change on climate, biodiversity, carbon dynamics, and water quality.

significant repercussions to people, the economy, and the environment. Some changes have natural causes, such as volcanic eruptions or drought, while other changes on the land, such as resource extraction, agricultural practices, and urban growth, are human-induced processes. There are other types of changes that are a combination of natural and human-induced factors for example, landslides and floods are fundamentally natural processes that are often intensified or accelerated by human land use practices. Land cover on the Earth's surface—the pattern of natural vegetation, agriculture, and urban areas—is the product of both natural processes and human influences. Land cover represents an unbiased signature of environmental conditions. Improved understanding about the consequences of landscape change assists decision makers in the fields of land use planning, land management, and natural resource conservation. The need for better information about land surface change is especially evident for changes brought about by wildfire, agricultural production, urbanization, forest logging, climate change and other factors operating at broad regional scales. USGS Geography research also includes linking satellite-based results to those observed from field-based monitoring programs, such as those generated by other USGS programs (stream gauge monitoring network, Breeding Bird Survey, National Water-Quality Assessment program) and other agency programs (the Environmental Protection Agency's Environmental Monitoring and Assessment Program). Creating these linkages provides for a powerful way to monitor important changes on the landscape that relate to a wide range of environmental characteristics valued by society.

Geography's objectives align with the Department of the Interior's (Interior) goal to improve the understanding of national ecosystems and resources. Geography supports USGS strategic objectives by making high-quality remotely sensed geospatial data widely and inexpensively available without restrictions to a global community of international, Federal civil, defense, Non-governmental organizations, State, local, academic, commercial, and individual users. Geography also supports USGS strategic objectives by efforts that further the understanding of the Nation's environmental, natural resource, and economic challenges through scientific assessments that provide a national and global perspective on land surface change.

Just as USGS' Science Strategy encompasses a broad range of national concerns that directly lend themselves to the mission of the Nation's natural resources research bureau, so too does the USGS manage the Nation's land imagery in support of a broad range of national and international purposes. Since the early days of spaceflight, the USGS has maintained the land imagery archive of the United States at its Center for Earth Resources Observation and Science (EROS), which contains nearly 100 years of satellite and aerial photographs of the land surfaces of the Earth. These archives are indispensable to USGS science and other national and international science investigations. Key among these imagery holdings is the archive of the Landsat program, the Nation's principal land-imaging satellite since 1972. Landsat provides the longest, most continuous land surface imagery of the entire Earth, a record unparalleled among the 45 other space and science programs in the world.

Program Evaluations

The National Academy of Science is conducting a review of "Geography's Strategic Directions for the Geographical Sciences in the Next Decade". This review will summarize research progress to date and outline future challenges. The committee is currently revising the report based on peer review comments and anticipates that the report will be released to sponsors and the public in the spring of 2010. The Landsat Data Continuity Mission (LDCM) will complete four Critical Design Reviews in 2010 as part of ensuring the Mission is on schedule and issues are resolved.

Subactivity Overview

The USGS Geography Activity is currently staffed by 547 FTE and approximately 650 contractors to carry out its activities within the following three budget subactivities:

The **Land Remote Sensing (LRS)** subactivity ensures continuous availability of Earth observations and other remotely sensed imagery for use by the Nation. The LRS activities include acquiring, archiving, disseminating, and promoting the application of remotely sensed data of the Earth's land surface. The LRS operates the Earth-observing satellites (Landsats 5 and 7) and acquires additional data through a multi-mission ground station. In addition, this subactivity is responsible for the development of the LDCM ground systems that will acquire, archive, process, and distribute data from the next Landsat 8. The LRS also procures commercial data from both aircraft and spacecraft operators and maintains a comprehensive archive of Earth observation data at the USGS EROS Center in Sioux Falls, South Dakota. Data from this archive are distributed to business partner retailers and customers. The LRS manages the National Civil Applications Program (NCAP), including the Global Fiducials Library (GFL), rapid exploitation applications, and source management for classified and unclassified data. It also promotes the application of remotely sensed information and advances the state of remote sensing technology. Data acquired and managed by the LRS are vital to applications such as support for national defense; global agricultural crop monitoring; monitoring and assessing the impacts of natural disasters; aiding in the management of water, biological, energy, and mineral resources; and analyzing the impacts of climatic and other global changes.

The **Geographic Analysis and Monitoring (GAM)** subactivity contributes to an understanding of changes occurring on Earth's land surface and the consequences of these changes, human and environmental. GAM provides the analysis and applications needed to address natural and human-induced changes on the landscape. Activities conducted in this program include land cover applications, global change research, ecosystems research, and producing a series of status and trends reports that document a national assessment of land surface change. Regarding science impact within GAM, it is a growing, cross-discipline effort to increase the use and value of USGS science in making informed decisions at Interior, at other Federal, State, and local agencies, and by citizens. The effort encompasses developing, testing, evaluating, and applying improved methods and processes to enhance linkages between science and decisionmaking.

The **National Geospatial Program (NGP)** subactivity creates and maintains *The National Map*, collects and integrates base national geospatial datasets, coordinates data discovery and access, and ensures consistent and current data are available for the Nation. Through the Federal Geographic Data Committee (FGDC), the USGS promotes and promulgates consistent geospatial data and metadata standards, enhances the National Spatial Data Infrastructure

(NSDI), and adoption of cross-government best business practices for geospatial resources, policies, standards, and technology.

Activity: Geographic Research, Investigations, and Remote Sensing

Subactivity: Land Remote Sensing

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change from 2010 (+/-)
Land Remote Sensing ($000)	61,718	0	63,707	-1,195	+13,350	75,862	+12,155
Total FTE	*142*	*0*	*146*	*-8*	*+3*	*141*	*-5*

1) $278 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Land Remote Sensing

Request Component	($000)	FTE
• Landsat Data Continuity Mission	+13,350	+3
TOTAL Program Changes	**+13,350**	**+3**

Justification of 2011 Program Changes

The 2011 budget request for the Land Remote Sensing (LRS) Subactivity is $75,862,000 and 141 FTE, a program change of +$13,350,000 and +3 FTE from the 2010 Enacted level.

Landsat Data Continuity Mission (LDCM) (+$13,350,000 / +3 FTE)

The USGS requests an increase of $13.35 million in 2011 to accommodate ground system requirements changes for the LDCM associated with moving the Operational Land Imager (OLI) sensor to a free-flying satellite system and the addition of a Thermal Infrared Sensor (TIRS) on board the spacecraft. The Mission Operations Element and the Flight Operations Team are related to the implementation of the LDCM as a free-flyer.

Program changes associated with the LDCM increase are described in section E, Secretary's Priorities and Mission Increases.

Program Overview

The Nation's economic and environmental vitality and security interests rely on continual observations of the Earth's land surface to understand changes on the landscape at local, regional and global scales. Improving our ability to monitor, analyze and permanently record these changes promotes continued economic expansion, environmental awareness, and the advancement of scientific knowledge to support policy officials and decisionmakers in fulfilling their public service responsibilities. Through the passage of the Land Remote Sensing Policy Act of 1992 (P.L. 102–555) Congress endorsed the need for continuous monitoring of the Earth and maintaining a readily available record of information displaying the status of its resources and environment. The LRS is meeting this need by ensuring continuous availability of moderate resolution and other remotely sensed imagery for the Nation.

The primary objectives of the LRS are to:

- Collect, process, archive, and distribute scientifically and operationally relevant global land and near-land observations;
- Ensure that these data are permanently maintained and easily accessible to the Nation;
- Conduct and sponsor research in land remote sensing applications to collect, archive, and distribute data, and investigate new remote sensing technologies; and
- Provide civilian agencies with the means to utilize classified assets.

Further guidance is provided by the U.S. National Space Policy (NSPD 49), dated August 31, 2006, which states: "The Secretary of the Interior, through the Director of the USGS, shall collect, archive, process, and distribute land surface data to the United States Government and other users and determine operational requirements for land surface data." In addition, the Department of the Interior (Interior) established a permanent Government archive, the National Satellite Land Remote Sensing Data Archive (NSLRSDA), containing satellite remote sensing data of the Earth's land surface—and makes these data easily accessible to users.

The LRS Program supports the mission of Interior and the USGS by providing high-quality remotely sensed data for understanding global changes of the Earth's landscape and by ensuring a comprehensive record of land surface data is available for environmental and economic decision making.

In 2010 and 2011, the LRS is continuing a comprehensive evaluation of the societal and economic benefits of moderate-resolution land imaging data and to the extent that resources are available, will begin steps towards implementing agreements to acquire new sources of moderate-resolution data to augment the existing Landsat data.

2011 Program Performance

Objectives of the LRS are met through the following components:

Remote Sensing Missions
(Estimates for 2009, $40.2 million; 2010, $40.2 million; 2011, $53.6 million)

The LRS is responsible for the operations and maintenance of the Landsat satellites and acquires remotely sensed land data from government, commercial, and international assets in support of Interior and the global Earth science community. The activities funded within the Remote Sensing Missions component include:

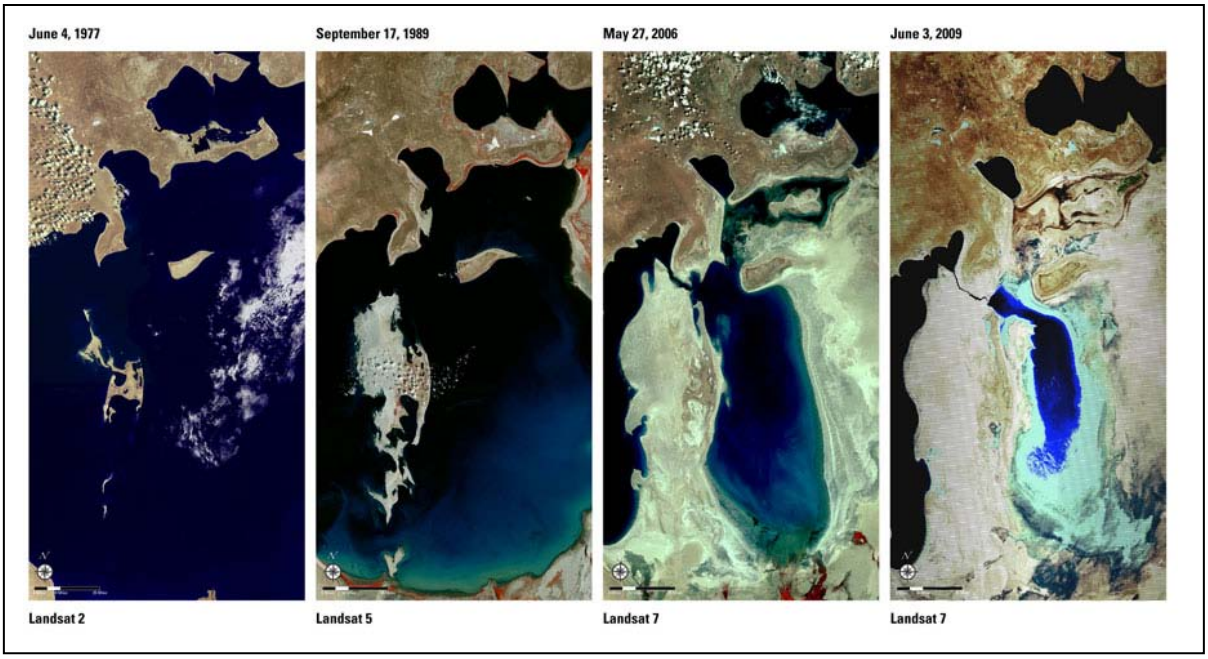
- Operation of Landsats 5 and 7 satellites, which includes flight operations, orbital maintenance, and management of all ground data reception, processing, archiving, product generation, and distribution;
- Coordination of mission requirements for users, including international cooperators;
- Maintenance of ground receiving stations, and implementing new technologies that support ground data reception and processing in preparation for long-term archiving; and,
- Support of ground systems development for the Landsat 8 satellite mission.

Landsat 5 and 7 Satellites – Landsat represents the world's longest, continuously acquired collection of space-based land remote sensing data. The Landsat Project is a joint initiative of the USGS and National Aeronautics and Space Administration (NASA) designed to gather Earth observations from space. NASA developed and launched the spacecrafts, while the USGS handles the operations, maintenance, and management of all ground data reception, processing, archiving, product generation, and distribution.

> ***"The opening of the Landsat archive to free, web-based access is like giving a library card for the world's best library of Earth conditions to everyone in the world."***
>
> Adam Gerrand
> Food and Agriculture Organization
> of the United Nations

Almost four decades' worth of Landsat data is used by government, commercial, industrial, civilian, military, and educational communities throughout the United States and worldwide. These data support a wide range of applications in areas such as global change research, agriculture, forestry, geology, resource management, urban planning, mapping, water quality, oceanography, and responding to natural disasters. No other current or planned remote sensing system, public or private, fills the role of Landsat in global change research or in civil and commercial applications. The Landsat series of satellites have provided imagery of the Earth's surface for over 37 years, making these data the most consistent, reliable documentation of global land surface change ever assembled. No other satellite system has such an unprecedented history of collecting data and monitoring changes of the Earth's landmasses.

During 2009, more Landsat data have been processed and distributed than in the entire history of the Landsat Program. Since October 2008, more than 1 million Landsat images have been downloaded free of charge by users around the world. One million Landsat images represent over 12 *billion* square miles which would cover the Earth's landmasses 225 times! The oldest data in the archive are now being downloaded at unprecedented rates further demonstrating the value of this continuous record of the Earth's changing land surface. Additional information on Landsat satellites can be found at: *http://landsat.usgs.gov/*.



The images above depict the vanishing Aral Sea between Kazakhstan and Uzbekistan in central Asia. Once the fourth largest lake in the world, the Aral Sea has shrunk dramatically as water is diverted for irrigation from its tributary rivers. As the water retreated, salty soil remained on the exposed lakebed. Dust storms have blown tons of this exposed soil, dispersing its salt particles and pesticide residues and pesticide residues and the resulting air pollution has caused widespread nutritional and respiratory ailments.

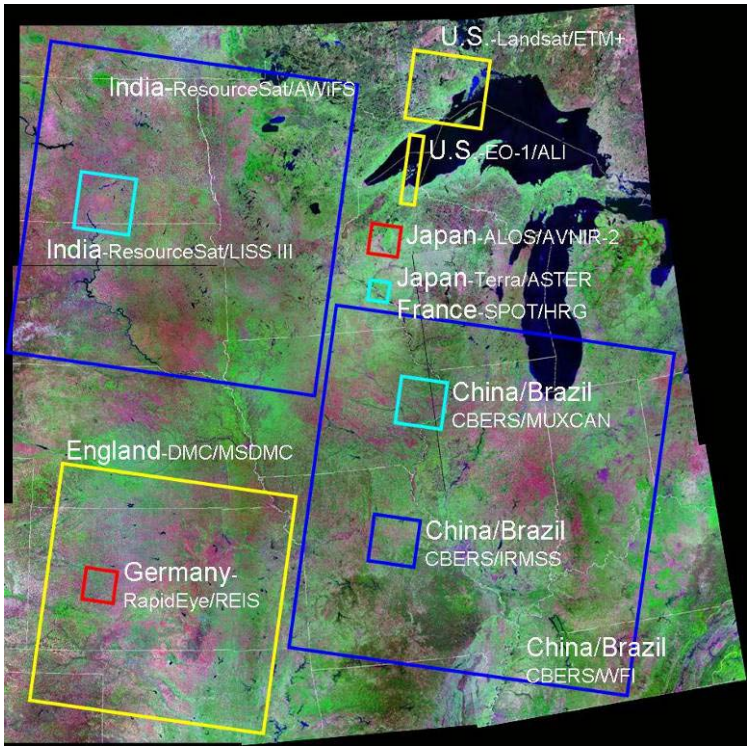
In 2010 and 2011, the USGS will maintain Landsats 5 and 7 flight operations and ground segment activities at the highest level of quality while continuing to improve the new operations model under the data policy change of free, web-enabled data for the entire archive. Flight operations, data capture, archive, standard product generation and distribution, and improvements to web-enabling all Landsat data products are some of the Program's top priorities.

Landsat Thermal Imagery Helps Western States – In the western United States, water is a precious and often contentious resource. Researchers in Idaho are using the USGS's Landsat thermal data to implement a new approach for more efficient water management. With the availability of Landsat thermal imagery, evapotranspiration (commonly referred to as "ET") is more accurately measured to determine water usage. The ET is the process of how water is converted from liquid to vapor at the Earth's surface and then transferred into the atmosphere. For decades, the ET has been estimated using ground-based observations, which covered limited areas only a few times a year. However, with thermal imagery from Landsats 5 and 7, efforts to quantify the ET made a quantum leap; they update the ET information several times during each growing season, showing the effects of different planting and harvest dates and differences in length of growing seasons, thus ensuring better agricultural use of water.

In 2000, the University of Idaho, teamed with the Idaho Department of Water Resources (IDWR) to develop a way to map the ET using Landsat imagery. Named 'METRIC' (Mapping EvapoTranspiration with high Resolution and Internalized Calibration), the new system provides high-resolution quantification of the ET. The result is a depiction of water use based on current, measured data that is tied to a specific location on Earth. METRIC provides new approaches

to methods of resource management including irrigation management, water rights administration, hydrologic modeling and natural habitat and endangered species monitoring. The value of METRIC has not gone unnoticed. In 2009, its developers received the Innovation in American Government Award from the Ash Institute of Harvard University.

Landsat 8 once on orbit, with its dedicated thermal instrument capturing two bands of thermal data, will reduce the reliance on the aging Landsats 5 and 7, thus ensuring a continual stream of thermal data for future ET monitoring and more efficient water usage, so crucial to resource management, water rights law and land use planning.

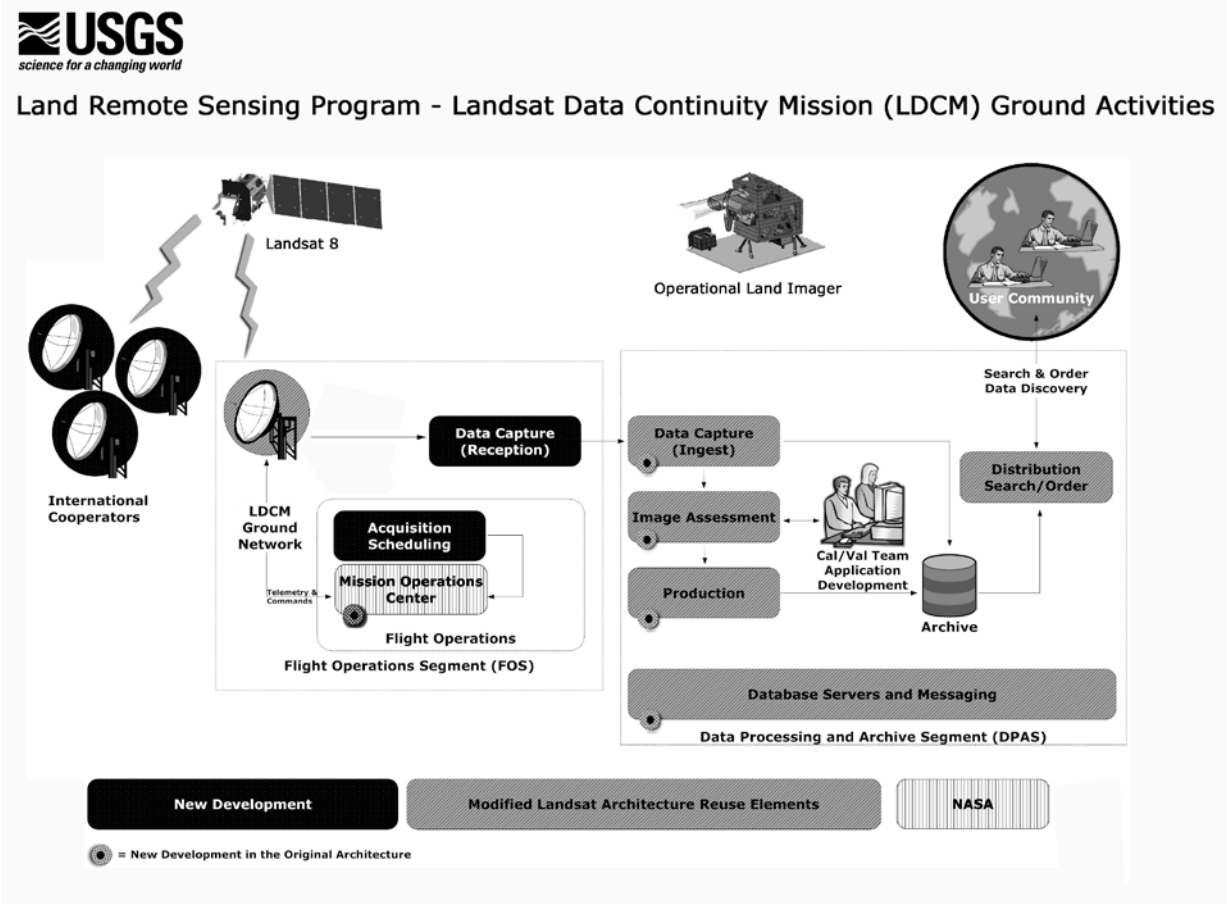


Landsat Data Gap Readiness Plan – The USGS has developed a comprehensive Landsat Data Gap Readiness Plan outlining necessary steps to "ready EROS and USGS contracts" whereby the USGS can immediately implement a data gap solution following the completion of Landsats 5 and 7. The plan outlines a set of options and capabilities to acquire Landsat-like data from one or more candidate data sources in order to mitigate a potential gap. Specific data access terms and conditions have been documented with five potential data providers, including the internal USGS EROS impacts for implementing any of these solutions pending a loss of Landsats 5 and 7. Five candidate satellite data sources were identified and evaluated, per recommendations of the Landsat Data Gap Study Team and other USGS considerations. The satellites are:

(1) SPOT (Satellite Pour L'Observation de la Terre) ;
(2) IRS ResourceSat (Indian Remote Sensing Satellite);
(3) CBERS (China/Brazil Earth Resources Satellite);
(4) RapidEye (German satellites); and,
(5) DMC (Disaster Monitoring Constellation).

Landsat Data Continuity Mission (LDCM) – The LDCM is the development phase for the next Landsat mission, also known as Landsat 8. LDCM is a cooperative effort between the USGS and NASA. Plans call for a 5-year mission, including enough consumables onboard for potentially 10 years of operation. NASA is developing the flight systems including the spacecraft, the instrumentation, the mission-operations element, the mission launch, and will

coordinate on-orbit checkout. The USGS is developing the ground system that will acquire, process, archive, and disseminate products from the OLI and the TIRS instruments to the user community. Following launch in December 2012 and on-orbit checkout, NASA will transfer ownership of Landsat 8 to the USGS. The USGS will then be responsible for flight operations, orbital maintenance, and data acquisition and delivery. Additional information on this mission can be found at *http://landsat.usgs.gov/documents/ldcm_factsheet.pdf*.



This graphic highlights the amount of Landsat data processing currently being re-used or built upon for the LDCM

In 2009, the USGS completed major LDCM milestones including:

- Evaluated and implemented cost savings/avoidance options
  - Maximizing reuse of the existing Landsat ground system
  - Augmenting and replacing capabilities where necessary
- Efficient completion of the Preliminary Design Review (PDR) for the Data Processing and Archive System (DPAS); no requests for action were issued by the independent review panel
- Successful completion of the PDR for the entire Ground System
- Supported NASA's reviews:
  - TIRS System Requirements Review and PDR
  - PDR for the overall Mission
  - Mission Non-Advocate Review

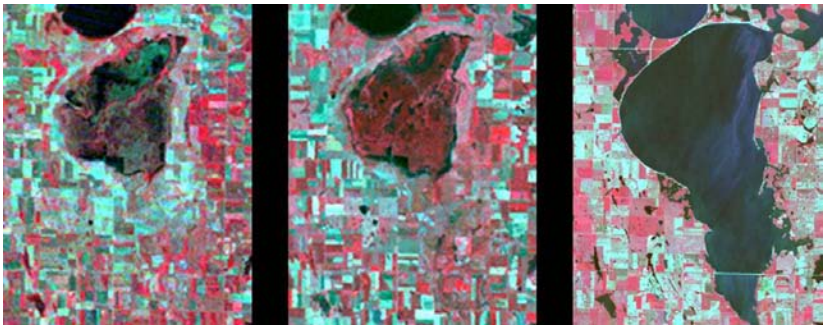
During 2010, efforts will continue to focus on system development and testing in preparation for the December 2012 launch. The DPAS and the flight operations segment must undergo a series of comprehensive testing in order to ensure that all ground systems are ready prior to launch. The USGS will also support NASA's reviews including Critical Design Reviews for the entire mission, as well as the TIRS. In 2011, the USGS requests an increase of $13.35 million to accommodate ground system requirements changes for the LDCM associated with moving the Operational Land Imager (OLI) sensor to a free-flying satellite system and the addition of a Thermal Infrared Sensor (TIRS) on board the spacecraft.

Landsat 8 will continue and greatly expand the Landsat record of Earth observations. The expanded daily collection rate, from the current 250 scenes per day to 400, will increase support for global land studies. The data, cross-calibrated with the nearly 40 years of observations in the Landsat archive, will let scientists undertake new applications over larger areas and longer periods of time, at a lower cost than previously available. The enhanced OLI spectral bands offer the potential of a wider range of new applications and improved image quality for traditional studies.

Landsat Science Team Mid-Term Review – The Landsat Science Team (LST) is a group of 18 scientists that were selected by the USGS through an open competition solicitation to provide technical and scientific input to the USGS and NASA in support of Landsats 1-7 and LDCM. The LST is completing its third year out of a 5-year contract period, and the team has sustained a regular schedule of meetings every January and June since its inception in 2007.

In January 2009, the team meeting was hosted by the U.S. Forest Service in Fort Collins, Colorado. During this meeting, the Deputy Director of the Western States Water Council presented an overview of the water information needs and strategies of the western states in which the importance of Landsat TIRS data was highlighted. These applications have stimulated increased awareness in Congress of the importance TIRS data for water management and monitoring water consumption for irrigation, and consequently have built strong advocacy and support for the deployment of a TIRS instrument on the LDCM.

At the June 2009 team meeting, a representative from the European Space Agency presented an overview of the Sentinel-2 mission that is under development to support the European Union's program of Global Monitoring for Environment and Security. This briefing and other presentations highlighted the importance of synergistic land remote sensing satellite capabilities which can provide the necessary repeat coverage and long term continuity of observations in support of numerous environmental monitoring requirements.



Landsat MSS images of Lake Thompson, South Dakota, showing the impacts of climate variability - July 5, 1973 (left); Landsat TM image, August 13, 1984 (center); Landsat ETM+ image, June 30, 2000 (right)

The LST convened special sessions at the Pecora 16 Conference in Denver, the American Geophysical Union Fall Meeting in San Francisco, and the American Society for Photogrammetry and Remote Sensing Annual Meeting in Baltimore, to highlight progress on the development of the LDCM and the benefits to the research and applications communities from opening the Landsat archives through no cost web-enabled data distribution. The team has been very active in advocating the need to initiate planning for Landsat 9 to ensure a sustained minimum 8-day repeat coverage of global Landsat data. This is crucial if the United States Government is to achieve major science objectives such as those articulated by the U.S. Global Change Research Program:

Long-Term Data Preservation and Access
(Estimates for 2009, $7.0 million; 2010, $7.2 million; 2011, $7.0 million)

The Earth's surface is constantly changing, which is difficult to observe and interpret from ground level. A much broader view is needed, together with a consistent record of global change over time. Satellites and aerial photography capture these views of the Earth's surface at regular intervals. By comparing past and present imagery, regional and global changes can be observed in an unparalleled way. The archives at the USGS EROS Center provide a comprehensive, permanent, and impartial record of the Earth's land surface acquired over several decades.

> *"…Preserving the digital scientific products of our time will ensure that future generations can benefit from our efforts and can better understand our time and place in history."*
>
> From the Report of the Interagency Working Group on Digital Data to the Committee on Science of the National Science and Technology Council, January 2009

The Land Remote Sensing Policy Act of 1992 directed Interior to establish a permanent Government archive (NSLRSDA) containing satellite remote sensing data of the Earth's land surface, and to make them available for study. The USGS is a world leader for archiving remotely sensed data, and responsible for making these data available and easily accessible to users. Today, the archive contains over 107,000 rolls of aerial and satellite imagery containing in excess of 13 million frames. It also contains additional aerial and satellite data sets, totaling 4,000 terabytes stored in robotic mass storage systems.

The core satellite data holdings include: Multispectral Scanner (MSS) (1972--1992) and Thematic Mapper (TM) image data (1982 to present) from Landsats 1-5 and Landsat 7; Advanced Very High Resolution Radiometer data (1979 to present) over the Earth's land surface from National Oceanic and Atmospheric Administration (NOAA) weather satellites; and over 900,000 declassified intelligence satellite photographs (1959--1980).

The USGS estimates an exponential growth in archival volume of satellite data to over 5 petabytes by 2013. In 2010 and 2011, the project continues to maintain, preserve and provide ready access to historical remote sensing film and digital databases and archives. Planned activities include data organization, ingest, metadata generation, data set appraisals and assessments, dispositions including transfer to the National Archives and Records Administration (NARA) and preservation activities, such as data set transcriptions and media migrations for collections.

USGS activities in 2010 and 2011 include:

- Operate and maintain systems to process and ingest satellite imagery for the historical record;
- Operate and maintain photographic and digital archives, and ensure long-term preservation of archival holdings, as well as improving public access to all archive holdings through continued digitizing of USGS historical film collections;
- Appraise and dispose of the historical collections; add new collections to the archive which are aligned to program objectives and the USGS mission;
- Web-enable historical data sets for no-charge electronic distribution, including creation of browse images and more effective metadata online, in order to better provide customers with data and imagery tailored to their needs; and
- Develop and begin executing a plan for transferring data sets, including those from the Terra and Aqua satellites, commercial and foreign data, into the NSLRSDA.

As of October, 2009, nearly 8,000,000 aerial and satellite image files were transitioned to an all-digital, Internet-accessible distribution system at no charge to the public using two USGS archive access systems: EarthExplorer: *http://earthexplorer.usgs.gov/* and Global Visualization: *http://glovis.usgs.gov/*.

In 2009, the USGS maintained and provided users with ready access to historical film, digital databases, and other remote sensing data for scientific and operational applications.

A New Album of Global Earth Imagery – A new collection of selected Landsat earth images worldwide, the Global Land Survey 2005, is now available for free download to any user around the globe. Under a long-term partnership, the USGS and NASA periodically select and process thousands of the best-available Landsat scenes in a Global Land Survey (GLS), recording baseline conditions across the Earth's land surface such as forest cover, urban sprawl, cropland areas, glacier size, regional snow cover, drought status, wildfire scars, and coastal features. All GLS images can be previewed and downloaded at no charge through either of two USGS web sites: *http://glovis.usgs.gov/* or *http://edcsns17.cr.usgs.gov/EarthExplorer/*.

Previous sets have been compiled for 1975, 1990, and 2000, providing the research community with a long-term record of full global observations. Preliminary efforts are underway for the creation of a 2010 data set, see http://landsat.usgs.gov/science_GLS2005.php. User demand for GLS data has been increasing steadily, with many scientists claiming these data sets are invaluable for global-change and climate-change research.

International Coordination and Collaboration – As the USGS provides national leadership for land imaging, the Bureau also continues remote sensing science and technology leadership in the international arena by providing remote sensing support for disaster response, as well as playing a lead role in international earth observation efforts. The USGS continues to serve as the lead U.S. agency to the International Charter "Space and Major Disasters," which provides a unified system of space data acquisition and delivery to those affected by natural or human-induced disasters. Each of the 10-member agencies has committed resources to support Charter provisions, thus helping in mitigating the effects of disasters on human life and property. As of July 1, 2009, the Charter had responded to 28 events, including 18 floods, 1 landslide, 3 hurricanes, 3 earthquakes and 3 volcanoes. The USGS submitted 6 of the 28 activations,

including an earthquake in Pakistan, floods in Washington, Indiana, and North Dakota, fires in Australia and an earthquake/volcano in Saudi Arabia.

The USGS will continue leadership and international coordination activities through its participation in the Committee on Earth Observation Satellites (CEOS). These efforts include CEOS Plenary support and membership in CEOS' standing Working Groups on Calibration and Validation, on Information Systems and Services, and on Education and Training. The USGS also has the lead role in development of a prototype for the "Land Surface Imaging Virtual Constellation" -- a CEOS action for the Global Earth Observation System of Systems initiative (for more information, see the web portal at *http://wgiss.ceos.org/lsip/*). This activity serves to coordinate civil space-borne observations of the Earth through international coordination and data exchange in order to optimize societal benefit on a global scale.

Off-Site Archiving – Building upon the success of 2008, when a contract was negotiated with NARA for off-site archiving at their Kansas City underground facility, the use of the contract was expanded to include Landsat and other satellite and aerial data. Nearly 1 petabyte of electronic records will be protected at this off-site facility by the end of calendar year 2009, thereby safe-guarding our Nation's observational records in case of a natural or human-induced tragedy.

Remote Sensing Research and Applications
(Estimates for 2009, $7.5 million; 2010, $7.6 million; 2011, $7.0 million)

The LRS conducts and sponsors research in remotely sensed land data collection, access, distribution, and applications. Scientists and engineers sponsored by the program are investigating new types of satellite systems and sensors, studying promising new data sources, developing new data acquisition programs and sources, and assessing the potential for new data applications. The program is seeking new ways to make remotely sensed data products more accessible, and to expand and enhance the overall use of remotely sensed data and remote sensing technology.
Additional information on LRS research can be found at: *http://remotesensing.usgs.gov/researchapps.php*.

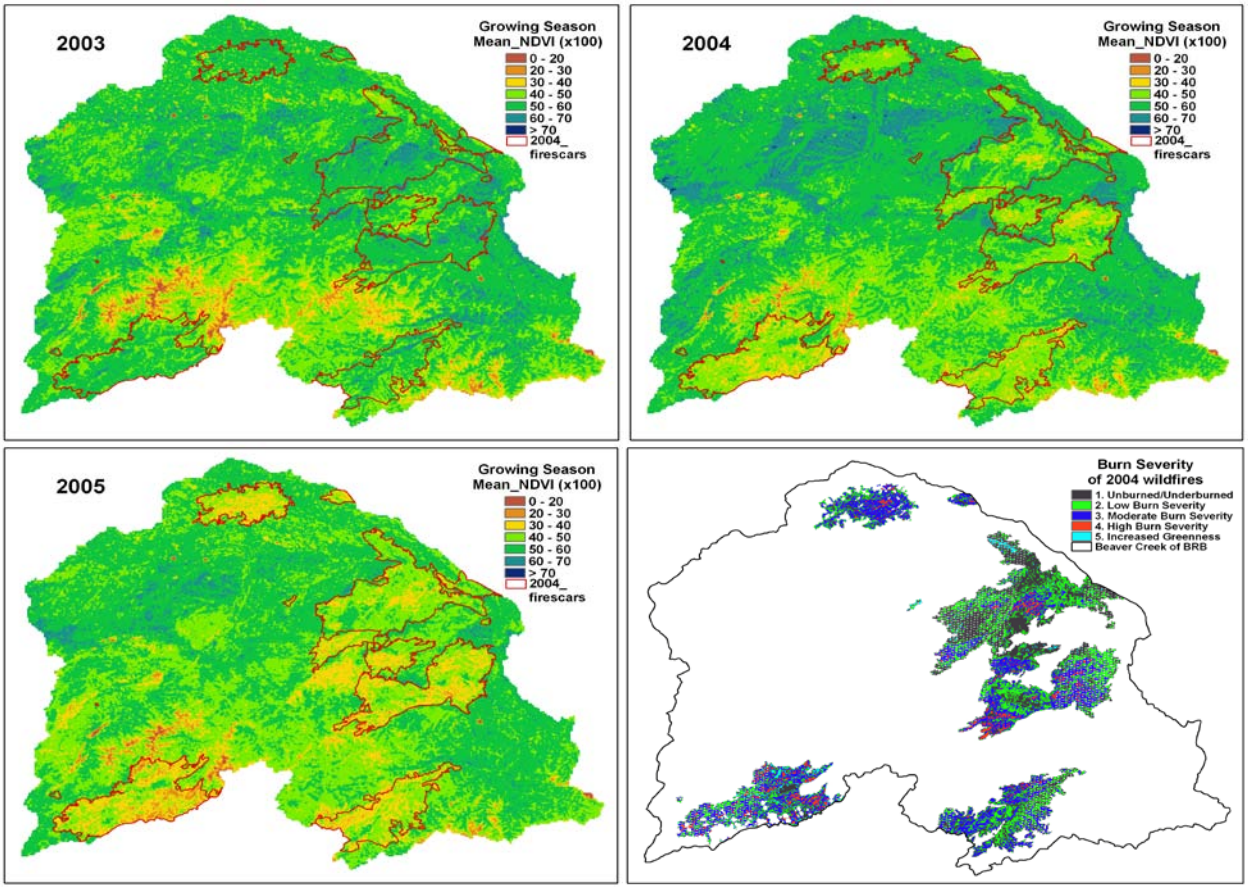
> *"A big segment of the future of aviation will include Unmanned Vehicles. They will not replace manned aviation, but a lot of DOI missions will be better and more safely performed by UAS. This Raven training is a big first step for DOI toward that goal."*
>
> Harry Kieling
> Aviation Management Directorate, DOI
> Alaska Regional Director
> (and a student in this first class)
> September 2009

Unmanned Aerial Systems (UAS) Technologies – The USGS UAS project office is leading the implementation of an exciting new technology that will transform the methods and techniques employed across the Interior and the USGS. Technology originally developed by the U.S. Army is now available to monitor environmental conditions, analyze the impacts of climate change, respond to natural hazards, understand landscape change rates and consequences, conduct wildlife inventories and support related land management missions. The USGS is teaming with Interior's Aviation Management Directorate (AMD) to lead the safe and cost effective adoption of UAS technology by Interior bureaus and USGS scientists. During September 2009, an important milestone was reached when the USGS sponsored the first UAS training for Department employees. The course was attended by students representing the USGS, National Park Service, Bureau of Land Management, AMD, and the U.S. Forest Service. Each student received instruction in basic and advanced flight skills, airspace management, aviation safety, emergency procedures, crew coordination, and mission planning. This impressive accomplishment helped establish the USGS and Interior as pioneers in the civilian applications of unmanned aircraft.

The Potential of Light Detection and Ranging (LiDAR) – The USGS is currently working to expand the availability and consistency of LiDAR data to address some of the Nation's most pressing climate, infrastructure and environmental issues. In 2009, the USGS LiDAR Advisory Committee was instrumental in establishing a set of data specifications for new LiDAR procurements to ensure that data are consistent and useful for multiple mapping and science applications across the USGS and to the benefit of USGS partners. These specifications were included in the USGS American Recovery and Reinvestment Act of 2009 assistance funds for the collection and processing of high resolution elevation for The National Map. Members of the Committee met with the National Geospatial Advisory Committee, the Federal Geographic Data Committee and a variety of other Federal, State and industry stakeholders to discuss a National LiDAR program concept, which has emerged as high priority within agencies and at National conferences and forums. The Committee also expects to convene a USGS conference in late 2010 or early 2011 to comprehensively explore LiDAR's ability to advance USGS strategic science objectives. The USGS is now heavily reliant on LiDAR technology for The National Map and is using LiDAR in many specialized science projects from detecting geologic faults to characterizing habitats and ecosystems.

Pinpointing Drought from Coast to Coast – The Vegetation Drought Response Index, known to specialists as VegDRI, is a computer modeling and monitoring method providing continuous drought information over large regions and supplies finer spatial detail than other commonly used drought indicators. In 2009, the index became available at 2-week intervals across the conterminous United States. VegDRI integrates time-series observations of vegetation with climate, land cover-land use type, ecological setting, and soil characteristics to show drought's effect on vegetation at a 1-kilometer resolution. The massive remote sensing archives at the USGS EROS supply historical satellite data from the last 20 years that are critical in establishing a sound comparison to normal conditions established over a longer historical period.

Monitoring Climate Change in the Yukon River Basin – The Yukon River Basin (YRB) in interior Alaska, like other high latitude areas, has experienced pronounced warming and increased wildfire disturbances. The ecosystems within the YRB are vulnerable to the effects of climate warming because most of it contains permafrost that likely degrades with climate warming. These ecosystems have high carbon densities and can accelerate climate change because degraded permafrost releases carbon into the atmosphere. To evaluate the vulnerability of boreal ecosystems, the USGS used the greenness index as one of the indicators of how these ecosystems respond to climate warming and wildfire disturbances. USGS analysis of data derived from satellite imagery from 2000 through 2006 shows that the growing season started earlier, and both the annual average and maximum vegetation index within burned areas changed dramatically before and after fires.



Graphs displayed here show a case study area, Beaver Creek of the YRB, where wildfires caused a lower vegetation index

Civil Applications Projects

(Estimates for 2009, $7.0 million; 2010, $8.7 million; 2011, $8.3 million)

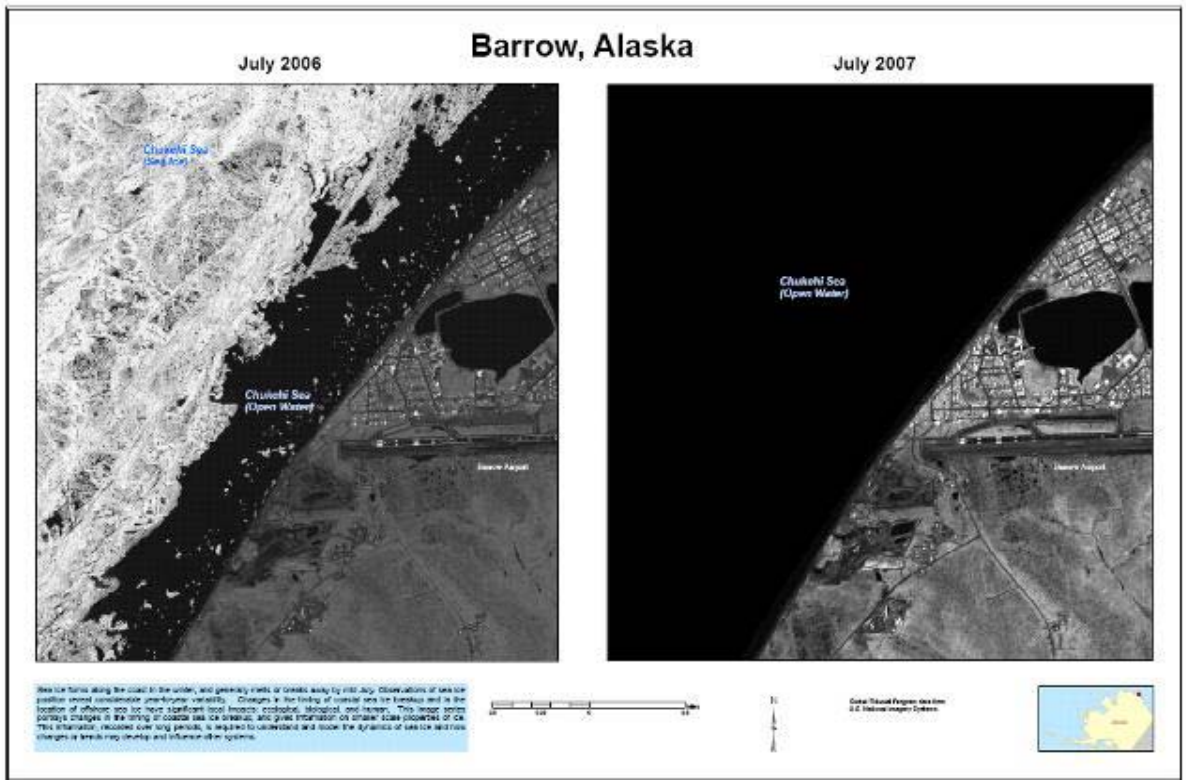
National Civil Application Program (NCAP) – The NCAP serves USGS science programs and other Federal civil agencies by providing for the acquisition, dissemination, archive, and exploitation of classified remote sensing systems and data to address land and resource management, environmental, socioeconomic, hazards, disasters, and other geospatial scientific analysis and policy issues. In addition, the NCAP provides support for the Civil Applications Committee, an interagency committee that provides coordination and oversight of Federal civil use of classified collections.

The LRS currently funds two secure facilities, in Reston and Denver, which support the complex infrastructure of security precautions and information technology (hardware, software, networks, etc.) necessary to enable the dual use of classified systems and capabilities. The NCAP activity serves as a key point of entry for the civil community to gain access to the significant resources the Intelligence Community has dedicated in areas such as: technology transfer and awareness of advanced image processing and analysis techniques, sensor research, and applications research.

In 2010 and 2011, the NCAP will addressing geospatial requirements associated with Federal lands management and preparation for, mitigation of, response to and recovery from hazards

and other emergencies. The NCAP also supports the preservation of a long-term record of classified earth observations, which are useful for scientific evaluation of global dynamics, such as climate variability and change. Through the NCAP, the LRS provides decision-makers with the best available, scientifically sound information based on the awareness, utilization and synthesis of all classified, open source, and governmental remotely sensed data.

The USGS Releases Image Library in support of Climate Change Studies – The USGS is making available to the public declassified images from the GFL. The GFL maintains a long-term archive of images from U.S. National Imagery Systems for selected environmentally sensitive and scientifically important sites to support current and future researchers and policy makers in identifying and understanding long-term environmental trends and processes. These images are being released to the public through the GFL website (*http://gfl.usgs.gov/*) to support analysis of global climate-related science and environmental change.



The public poster shows a one-year difference in the breakup of ice near Barrow, Alaska. The image series collected over this Global Fiducial site helps monitor changes in the timing of fast ice breakup, and gives information on smaller scale properties of ice.

Civil Applications Committee (CAC) – The CAC is an interagency committee that was chartered in 1975 to foster access to and assure proper use of National Systems data in support of civil agency's mission responsibilities. Since its inception, the CAC has facilitated access to and overseen the use of classified National Technical Means assets by its members in support of traditional mapping applications, as well as a broad range of resource management, environmental, climate, natural disaster, and remote sensing applications. The CAC is operated and staffed by the USGS on behalf of Interior. The CAC has a membership of six Cabinet-level Departments and six Federal agencies. In 2010 and 2011, the CAC will continue to:

- Foster information sharing for the civil community and will seek to provide CAC members access to the skills and information necessary to protect and maximize the use of assets;
- Facilitate relationships between the Civil and the Intelligence communities to identify and document their requirements; and
- Expand a monthly inter-community forum for technology and information exchange to a much broader audience.

Program Performance Overview

The following highlights important performance measures for the Land Remote Sensing Subactivity:

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of critical milestones successfully reached to support the LDCM launch schedule **(LRS)**	C	UNK	4% 1/23	35% 8/23	52% 12/23	52% 12/23	70% 16/23	83% 19/23	+13%	91% 21/23
Comment	The current number of critical milestones to be reached in support of the LDCM launch schedule is 23.									
Efficiency and Other Output Measures										
# of terabytes collected annually **(BUR) (LRS)**	A	287.5	288.9	261.3	270	158.8	165	165	0	165
# of terabytes managed cumulatively **(BUR) (LRS)**	C	3,425.3	4,255.9	3,840.6	4,300	3,010.9	4,000	4,000	0	4,000
# of systematic analyses and investigations completed **(BUR) (Geography)**	A	79	67	93	65	90	65	92	+27	92
Comment	The 2010 Plan reflects estimates for performance outcomes that were included in the 2010 President's Budget request. The estimates for the 2011 Plan are based on actual performance in 2009.									
Total projected cost ($000)		**43,012**	**46,441**	**24,180**	**16,900**	**23,400**	**16,900**	**23,920**	**+7,020**	**23,920**
Actual projected cost per Analysis (whole dollars)		**544,452**	**693,149**	**260,000**	**260,000**	**260,000**	**260,000**	**260,000**	**0**	**260,000**
# of formal workshops or training provided to customers **(BUR) (Geography)**	A	10	28	49	30	30	25	25	0	25

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Activity: Geographic Research, Investigations, and Remote Sensing

Subactivity: Geographic Analysis and Monitoring

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Geographic Analysis & Monitoring ($000)	10,598	0	11,135	-192	+750	11,693	+558
FTE	*66*	*0*	*66*	*-1*	*0*	*65*	*-1*

1) $186 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Geographic Analysis and Monitoring

Request Component	($000)	FTE
• Increasing Resilience to Natural Hazards	+250	0
• National Water Availability and Use Assessment	+500	0
TOTAL Program Changes	**+750**	**0**

Justification of 2011 Program Changes

The 2011 budget request for the Geographic Analysis and Monitoring (GAM) Subactivity is $11,693,000 and 65 FTE, a program change of +$750,000 and 0 FTE from the 2010 Enacted level.

Increasing Resilience to Natural Hazards **+$250,000 / 0 FTE**

Program changes associated with the Increasing Resiliency to Natural Hazards initiative are described in section E, Key Increases.

National Water Availability and Use Assessment **+$500,000 / 0 FTE**

Program changes associated with the National Water Availability and Use Assessment initiative are described in section E, Key Increases.

Program Overview

The Earth's surface is rapidly changing, at local, regional, national, and global scales, with significant repercussions for citizens, the economy, and the environment. Some of these changes are due to natural causes, such as volcanic eruptions, earthquakes, or drought, while other changes on the land, such as mining and forestry operations, agricultural practices, and urban growth, are human-induced processes. These changes do not act in a vacuum, but interact to both accelerate the rate of change and intensify their impacts. The GAM program studies these changes by creating datasets identifying the changes taking place, researching the impacts of the identified changes and developing tools and models that allow resource managers and communities to adapt to changing conditions and make knowledgeable decisions on resource use and allocation. These tools and models are important components in reducing the detrimental impacts of economic development and reducing a community's risk to hazard events.

Geographic Analysis and Monitoring:

The GAM Program conducts geographic research in support of the following goals:

- Characterizes and quantifies land surface status and trends, providing a framework for understanding change patterns and processes from local to global scales.
- Understands past, present, and future environmental consequences of land change and its impacts on the people, environment, economy, and resources of the nation.
- Improves the scientific basis for vulnerability and risk assessments, as well as disaster mitigation, response, and recovery activities.
- Develops credible and accessible geographic research, tools, and methods supporting resource allocation and decisionmaking.

Approximately, one-half of GAM's resources are devoted to developing and maintaining land surface datasets that provide the framework for environmental analyses and resource management. The National Land Cover Database (NLCD) for 2006 and the Ecosystems Mapping project are the two major datasets currently under development. The remainder of GAM's resources is used to fund geographic research critical to:

- Understanding the environmental consequences of land change and its impacts on the people, environment, economy, and resources of the nation;
- Improving the scientific basis for vulnerability and risk assessments, as well as disaster mitigation, response, and recovery activities; and,
- Developing and the necessary tools and methods to support resource allocation and decision-making.

Program researchers use earth observation data supplied by remote sensing platforms, *in-situ* environmental data, and socio-economic data to quantify the rates of landscape change, identify key driving forces, and forecast future trends of landscape change. Results of these studies are utilized by resource managers to plan future activities and responses to possible events that may result in loss of life, decrease in economic value, or degrade environmental resources. Studies are conducted within a geographic context at a range of spatial and temporal scales to provide a comprehensive, interdisciplinary perspective. This perspective is necessary to understand the threats impacting quality of life issues, such as climate change, natural disasters, infectious diseases, and suburban sprawl.

The science conducted by GAM plays a vital role in several important USGS-wide activities such as the Multi-Hazards Demonstration Project (MHDP) in southern California and the Wyoming Cooperative Conservation Initiative (WCCI). The goal of GAM in these initiatives is to utilize the most relevant data and geographic techniques to assess some of the most pressing issues facing resource and disaster managers in our nation.

2011 Program Performance

GAM includes the following components:

Land Change Science
(Estimates for 2009, $6.0 million; 2010, $6.5 million; 2011, $7.2 million)

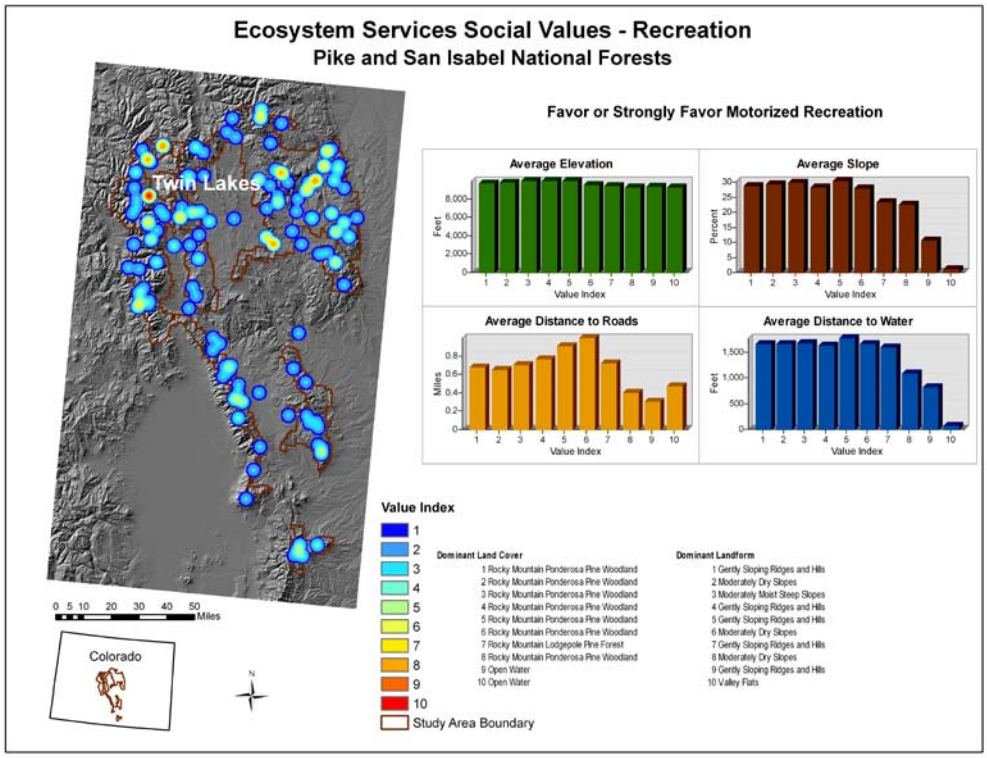
Land Change Science projects involve developing geospatial data sets needed to evaluate landscape conditions, changes, and trends over time, as well as scientific investigations linking landscape changes to fundamental ecological, physical, chemical, and hydrologic processes. This includes identifying land cover (the NLCD), and other biophysical characterizations of the Earth's surface (ecosystems, vegetation condition, soils, phenology, etc). It assesses major human and natural factors of change, incorporating but not limited to human infrastructure (i.e. roads), and socio-economic factors. These assessments include forecasting future environmental conditions in response to various land change scenarios. These studies also identify thresholds and tipping points of land changes and their impact on ecological processes and services (such as water filtration and carbon sequestration). They result in models, spatial metrics, and assessment tools that can be used to evaluate the consequences of landscape change at a range of spatial and temporal scales. The USGS will continue this work in 2011.

Ecosystem Mapping – Ecosystem models and data provide critical information to organizations and global conventions involved in climate change studies, land management analyses, and conservation efforts. A prerequisite to ecosystem management is an understanding of the types, distributions, and condition of the ecosystems that occur on the landscape. In 2009, the GAM program, in partnership with NatureServe, completed a three year effort to model the potential distribution of terrestrial ecosystems for the conterminous United States, which is now available online at *http://pubs.usgs.gov/pp/1768*). This activity is part of a larger global effort commissioned by the Group on Earth Observations (GEO) to classify and map global ecosystems. The United States is the GEO-designated member nation leading the global ecosystem mapping task, and the USGS is the responsible Federal agency for the work.

The National Land Cover Database – The NLCD provides consistent public domain information on the Nation's current land cover characteristics. Much of this work is accomplished through USGS partnerships with Federal, State and local government agencies, private industry, and non-governmental organizations. The NLCD currently consists of three major land cover data releases including a 1992 conterminous U.S. land cover (NLCD 1992); an updated 50-State/Puerto Rico U.S. land cover dataset (NLCD 2001); and an NLCD 1992/2001 land cover change product that is designed to identify land cover change between the two eras. These comprehensive sets of scientifically credible land cover data layers are used to support thousands of applications in land management, environmental studies, modeling and policy decisions. All NLCD products are web enabled for download at the Multi-Resolution Land Characteristics website at *http://www.mrlc.gov.* In 2009, an accuracy assessment of the NLCD 2001 was completed and full scale production of NLCD 2006 (updated land cover for the

nominal year of 2006) was initiated. Work on the NLCD 2006 will continue in 2010, along with planning the next iteration of land cover (NLCD 2011) and the NLCD 2006 accuracy assessment.

Social Values for Ecosystem Services – As human pressures on the natural world continue to increase, there is a growing need to incorporate quantitative information about coupled human-ecological systems into environmental decision-making. Public land managers are being asked to weigh tradeoffs associated with complex management decisions that require information on market and non-market values of ecosystems goods and services that benefit humans. In 2009, the USGS in collaboration with Colorado State University began efforts to develop a Geographic Information System (GIS) application that will permit the inclusion of spatially explicit, quantitative information on societal values into these analyses. The Social Values for Ecosystem Services (SolVES) tool is being designed to assess, map, and quantify perceived social values for ecosystem services. SolVES will be compatible with a wide range of existing tools for ecosystem services assessment and valuation, and will be distributed as an open source, public domain application to promote adoption and extension by others. In 2010 and 2011, the USGS will apply and evaluate SolVES within the context of a multi-agency ecosystem services assessment and valuation project to address public lands management.



Modeling Ecosystem Carbon Dynamics – In 2009, GAM program researchers assessed the carbon dynamics of the Green River Basin in Wyoming, revealing that grazing had a larger impact on the carbon cycling in the sagebrush ecosystem than on the grass ecosystem and that overgrazing could result in an overall decrease in the amount of carbon sequestered. One strategy to enhance soil carbon sequestration in this region is to convert sagebrush to grassland. However, researchers found that this would only work in the first six to seven years, then likely lead to losses of sequestered carbon in the long term. In 2010, this research will be expanded to other geographic regions, including a study that encompasses all of the Great

Plains and creating adaptive management tools that enable resource managers to utilize this information in assessing the sustainability of grazing practices.

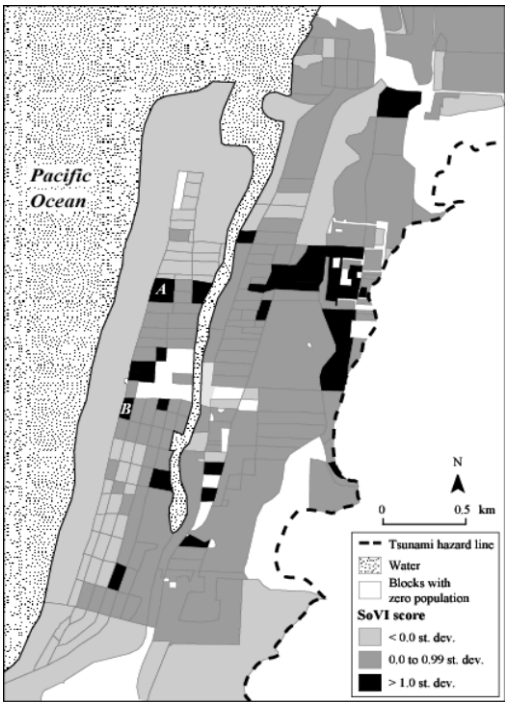
Assessing Societal Vulnerability to Natural Hazards
(Estimates for 2009, $4.6 million; 2010, $4.6 million; 2011, $4.5 million)

These scientific investigations utilize models, sensitivity analyses, geographic distributions of people and infrastructure, and the probability of specific disturbance factors occurring, to evaluate a community's vulnerability and risk. The GAM program helps local and State governments by augmenting their traditional expertise in natural hazards with improved capacity to assess vulnerability, defined here as the exposure, sensitivity, and resilience of a community. These projects include case studies, interpretative assessments, and science impact studies involving stakeholders and other clients in collaborative processes. The USGS will continue this work in 2011.

Land Use Portfolio Model (LUPM) – In 2009, GAM researchers finalized development of the LUPM, a tool for modeling, mapping, and communicating risk. The tool is designed to help public agencies and communities understand and reduce their vulnerability to, and risk of, natural hazards. Researchers have focused on performing two main tasks, core model development and software development. Core model development involves deriving model equations, developing theoretical and applied techniques for risk analysis, and adapting the model as needed by particular applications. Current ongoing work includes: updating the measures of model uncertainty; quantifying component dependencies such as spatial autocorrelation of failures; analyzing different planning-time horizons; integrating the LUPM with loss-estimation tools; developing a natural-hazards risk-assessment framework that incorporates multiple natural hazards; and exploring standard and innovative approaches to vulnerability assessment. Experience gained from the MHDP earthquake scenario is contributing to the conceptualization and estimation of societal vulnerability for other municipalities.

Coastal Lands Vulnerable to Sea Level Rise – Project accomplishments in 2009 include lead authorship of Chapter 2 titled "Coastal Elevations" in the interagency U.S. Climate Change Science Program's report "Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region" (see *http://www.globalchange.gov/publications/reports/scientific-assessments/saps/sap4-1*). Preparation of the report was a multi-year effort led by Environmental Protection Agency in collaboration with the USGS, NOAA, and several universities and other organizations. The key findings identified in this report are now being applied in ongoing USGS sea level rise assessment research.

Risk and Vulnerability to Natural Hazards – GAM research is focused on the development and application of GIS technology and community-based processes to assess and communicate societal vulnerability to sudden-onset and chronic hazards. Reducing life loss and property damage from natural hazards is one of the critical issues of the 21st century. To help officials and communities in their efforts to reduce potential losses, the USGS is augmenting its traditional expertise in natural hazards with improved capacity to assess and communicate societal vulnerability. Project results are focused on providing geographic information that helps officials make informed and realistic decisions on mitigation, outreach, preparedness, response, and recovery strategies for increasing community resilience to hazards. Accomplishments in 2009 include: (1) an article in *Applied Geography* describing the use of NLCD data to approximate variations in community exposure to tsunamis on the Oregon coast (fig. 1); (2) an article in *Natural Hazards* describing variations in demographic sensitivity to tsunamis on the Oregon coast; and (3) an article in the *Journal of Volcanology and Geothermal Research* that describes variations in population exposure to lahar hazards near Mount Rainier. These three articles each describe innovative approaches to using GIS technology to characterize various aspects of socioeconomic vulnerability to natural hazards. Technical briefings of these reports and articles were given to local, State, and Federal partners. In 2010 and 2011, project plans include the assessment of socioeconomic exposure for all continental United States volcanoes, completion of a National Research Council review of the Nation's tsunami preparedness, assessments of variations in community exposure to coastal hazards enhanced by climate change in Florida (storm-surge hazards) and Oregon and Washington (coastal erosion and flooding), and an assessment of adaptive capacity to sudden-onset hazards related to Mount Hood (Oregon).



Map of a tsunami-hazard zone and census blocks, classified by Social Vulnerability Index (SoVI) scores, in the City of Seaside, Oregon.

Program Performance Overview

The following highlights important performance measures for the Geographic Analysis and Monitoring Subactivity:

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of US surface area with contemporary land cover data needed for major environmental monitoring and assessment programs **(SP) (Geography)**	C	94%	95% (286/300)	99.3% (298/300)	40% (120/300)	46% (213/463)	95% (440/463) complete the NLCD 2006 product	100% (463/463) Completes NLCD 2006; develop prototype for next NLCD product	5%	20%
Comment	The current plan is to complete the NLCD 2006 update in early 2011. This product uses 2006 imagery and compares it to the NLCD 2001 data layers to provide an update of where land cover has changed over the five years. During 2011, the USGS will also be preparing for producing NLCD 2011, working with the Multi-Resolution Land Characteristics Consortium partners to develop prototype products. Full scale NLCD 2011 production will begin in 2012.									
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (Geography)**	A	79	67	93	65	90	65	92	+27	92
Comment	The 2010 Plan reflects estimates for performance outcomes that were included in the 2010 President's Budget request. The estimates for the 2011 Plan are based on actual performance in 2009. The 2011 Plan also includes 2 additional systematic analyses as a result of the Increasing Resilience to Natural Hazards initiative.									
		43,012	**46,441**	**24,180**	**16,900**	**23,400**	**16,900**	**23,920**	**+7,020**	**23,920**
		544,452	**693,149**	**260,000**	**260,000**	**260,000**	**260,000**	**260,000**	**0**	**260,000**
# of formal workshops or training provided to customers **(BUR) (Geography)**	A	10	28	49	30	30	25	25	0	25

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Activity: Geographic Research, Investigations, and Remote Sensing

Subactivity: National Geospatial Program

	2009 Actual	2009 Recovery Act [3]	2010 Enacted [4]	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
National Geospatial Program ($000)	0	0	70,748	-1,361	-3,500	65,887	-4,861
Total FTE	*0*	0	*330*	*-3*	*-4*	*323*	*-7*

1) $840 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.
4) In 2010 the National Geospatial Program moved to Geography from Enterprise Information.

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Summary of 2011 Program Changes for National Geospatial Program

Request Component	($000)	FTE
• *The National Map* Partnerships	-3,500	-4
TOTAL Program Changes	**-3,500**	**-4**

Justification of 2011 Program Changes

The 2011 budget request for the National Geospatial Program (NGP) Subactivity is $65,887,000 and 323 FTE, a program change of -$3,500,000 and -4 FTE from the 2010 Enacted level.

***The National Map* Partnerships** **-$3,500,000 / -4 FTE**

For 2011, the USGS proposes to reduce the funding for the Partnership Implementation component by $3.5 million. The proposed reduction eliminates all funds used to leverage with Federal, State and local agencies to acquire new data. Through this leverage, the USGS typically benefits from a ratio ranging from 15:1 for imagery to 4:1 for hydrography data. The amount of the proposed reduction actually results in the loss of as much as $20 million worth of geospatial data to the Federal Government, the USGS, and the public annually. This reduces the USGS' ability to maintain the currentness and improve the quality of *The National Map*.

The proposed decrease would eliminate liaison positions responsible for partnerships in 13 States. These personnel organize the agreements through which the USGS leverages its resources with those of State and local cooperators. They routinely provide important services of coordination among Federal geospatial resources and those of State and local governments. Such services are invaluable during emergencies.

Beyond these immediate outcomes, the reduction would result in less work for America's geospatial industry, which benefits by fulfilling contracts for projects that result from agreements the NGP makes with its cooperators. The reduction also undermines a fundamental strategy to maintain the Nation's geospatial framework that has been recommended by the Office of Management and Budget, the FGDC, and the National Academy and other advisory groups.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
Square miles of high resolution elevation data collected in Priority Areas and added to the 1/9 arc-second (3 meter) National Elevation Dataset (NED) **(NGP) (Base Funds)**	NA	93,153	66,000	58,000	58,000	29,000	-29,000	0
Square miles of high resolution, leaf off (<1m) orthoimagery data collected in the US and its territories added to the NGP orthoimagery database **(NGP) (Base Funds)**	UNK	79,751.35	253,192	200,000	200,000	75,000	-125,000	0
% of total cost FSA and USGS saved through partnering with other entities for imagery acquisition of 1-meter NAIP orthoimagery **(NGP)**	32% (2.3/7.2)	27%	18% (4.3/23.8)	40% (5.6/14)	40% (5.6/14)	0	-40%	0

Note: Projected costs may not equal program change as these are full costs, which may include funds from other sources and (or) use averages.

Column A: The level of performance and costs expected in 2011 at the 2010 level plus funded fixed costs. Reflects the impact of prior year funding changes, management efficiencies, absorption of prior year fixed costs, and trend impacts, but does not reflect the proposed program change.

Column D: Outyear performance beyond 2011 addresses lagging performance—those changes occurring as a result of the program change (not total budget) requested in 2011. It does not include the impact of receiving the program change again in a subsequent out-year.

Program Overview

The NGP organizes, maintains, and publishes the geospatial baseline of the Nation's topography, natural landscape, and built environment, such as transportation features. The baseline is *The National Map*, a set of databases of geospatial data and information and related services and products. The NGP provides the content of the geospatial databases that users can download, provides web-based information services that deliver the content, and publishes products derived from the content. The program works with cooperators to share the responsibilities and costs of acquiring and maintaining these geospatial data, and with customers to ensure that the products and services meet their needs.

Emergency Aerial Imagery Support to Kentucky After the 2009 Ice Storm

"First, let me state for the record that the response and actions by USGS, FEMA, and DHS regarding this project were among the best I've ever witnessed. The time from request to downloadable product was as quick as anyone could expect. Everyone's help is appreciated. ...

Overall, I would give this part of the storm response very high marks in quality and usefulness. I hope and feel that we can count on this type of support for future events and disasters, with the same professional quality. …"

Kenny Ratliff, GIS Manager
Kentucky Army National Guard

(Written in support of the efforts of the NGP-funded geospatial liaison in Kentucky)

This geospatial information is a critical foundation of USGS and the Department of the Interior (Interior) science. It provides the geospatial framework for accomplishing the strategic directions of the 2007-2017 USGS Science Strategy (see Section B for a more full discussion of the Science Strategy).

More broadly, the NGP provides products and services to the Federal, State and local governments, and the public. In a recently published survey of customer requirements for *The National Map*, 2,200 individuals, including those from Federal and State agencies, identified five communities of interest: resource management, climate and environment, human services and infrastructure, disaster response and homeland security, and energy. Customers incorporate the products and services from the NGP in their internal business processes to support decision making and operational activities. Open access to these same products and services allows the public to use them to understand and participate in public actions taken by government organizations.

The National Geospatial Program:

- Organizes, maintains, and publishes the geospatial baseline of the Nation's topography, natural landscape, and built environment. The baseline is *The National Map*, a set of databases of geospatial data and information, and related products and services.
- Provides current, accurate, and consistent geospatial data and map services online through *The National Map*, The National Atlas of the United States of America®, and the Geospatial One-Stop web portal
- Funds the FGDC Office of the Secretariat and promotes consistent data and metadata standards, system interoperability, and cross-government best business practices for geospatial resources, policies, standards, and technology.
- Collaborates on research needed by *The National Map*, National Spatial Data Infrastructure, and emerging geospatial web.

Another benefit the public receives from these products and services results from the incorporation of NGP-provided information into commercial map products and services. The recent incorporation of hydrography data (map information about streams and lakes) into the Google Map™ mapping system is a recent example of a relationship that has existed for 125 years between the USGS and commercial

map makers and geospatial data providers. These relationships result in improved products for the public and a robust American geospatial industry.
The NGP will publish its 2011-2015 five-year strategic plan early in 2011. The plan will lay out the direction for the program and performance measures to assess its progress towards its goals. As the strategic plan is developed, in 2010 and 2011 the NGP is developing enterprise architecture, a management practice for aligning resources to improve business performance and help the program better execute its core mission. The effort will follow the Federal Segment Architecture Methodology, the method endorsed by the Office of Management and Budget (OMB) to develop an enterprise architecture.

Through its responsibilities to the e-government initiative Geospatial One-Stop, the program provides a clearinghouse of information about geospatial data of all types and from all sources. It also provides an online "marketplace" where providers and users of geospatial data can exchange information about data availability and needs, and thereby reduce duplication of effort.

The program also hosts the FGDC Office of the Secretariat (FGDC-OS). The FGDC is an OMB-chartered interagency committee responsible for facilitating activities related to OMB Circular A-16 and implementation of the National Spatial Data Infrastructure (NSDI).

2011 Program Performance

The NGP is organized in six budget components: *The National Map*, The National Atlas of the United States of America®, Emergency Operations, Center of Excellence for Geographic Information Science (CEGIS), Partnership Implementation, and FGDC-OS. For details on performance measures, see the table at the end of this section.

> *"I want to extend my sincere appreciation for the mapping expertise that the US Geological Survey has recently provided. . . [USGS] demonstrated exceptional customer service in support of our catastrophic earthquake planning. . . ensured our mapping requirements for pre-disaster planning efforts were met . . . and rapidly responded with the highest quality of mapping portrayal available for the Salt Lake City area.. . . [USGS] provided exceptional customer service in support of FEMA's mission. . ."*
>
> Douglas A. Gore, Acting Regional Administrator
> FEMA Region VIII
> June 24, 2009

The National Map

(Estimates for 2009, $42.1 million; 2010, $42.9 million; 2011, $41.8 million)

The National Map component ensures that nationwide, current, consistent, seamless, and integrated geospatial data are organized, maintained, and published. These characteristics are important to customers, especially Federal agencies, because they support business needs that require consistent and high-quality information over large parts of the Nation (for example, land management resource applications), that occur for any arbitrary place in the Nation (for example, disaster response or homeland security applications), or require a sampling of places from across the Nation for which there are consistent information (for example, environmental applications).

These data, available through *http://nationalmap.gov*, are published as map products and Internet-based services that customers incorporate into the decision making and operational processes.

The NGP obtains updates to these data through cooperation with Federal, State, local government agencies (see the Partnership Implementation component for more discussion) and contracts with the private sector.

Another activity funded in this component is the Geospatial One-Stop (GOS) web portal, which provides access to and discovery of geospatial data to meet the science, land, and resource management needs of State, Federal, local, industry, and public users.

Data Themes in *The National Map*

Work under this component provides base geospatial data for seven data themes: orthoimagery, elevation, hydrography, geographic names, transportation, structures, and boundaries. It also uses the land cover data produced through the USGS Geographic Analysis and Monitoring program.

The USGS is the Federal bureau assigned responsibilities by OMB Circular A-16 for interagency leadership of several data layers. Through *The National Map*, the NGP carries out these responsibilities for digital orthoimagery, terrestrial elevation, hydrography and watershed boundaries, and geographic names. The NGP also has responsibilities for uniform geographic name usage throughout the Federal Government under Public Law 80-242. The NGP allocates most of its resources to organize, maintain, and publish orthoimagery, elevation, hydrography, and geographic names information.

Orthoimagery – An orthoimage is an aerial or satellite image of the Earth that is processed so that accurate positions, distances, and areas can be measured from it. Orthoimagery is an essential base layer in geospatial databases in nearly all levels of government. It also is very popular in industry and the public.

The USGS ensures that the orthoimagery in *The National Map* is up-to-date and serves as a primary component of its graphic program in support of the new US Topo digital map.

The NGP acquires orthoimagery through the private sector, either through USGS contracts or those of other cooperating public agencies. As the data are delivered, the NGP provides quality assurance, data maintenance, archive, and distribution services for terabytes of public domain orthoimagery data.

The USGS collaborates with other government agencies at the Federal, State and regional levels to acquire orthoimagery, at resolutions ranging from 1-meter to 6-inches. The bureau is a founding member of the National Digital Orthoimagery Program, a consortium of Federal and State agencies allied for the purpose of developing and maintaining national orthoimagery coverage in the public domain through cooperation among Federal, State, local, tribal, and private organizations.

For the Nation's urban areas, the NGP collaborates annually with the National Geospatial-Intelligence Agency (NGA) to acquire orthoimagery at 1-foot or better resolution orthoimagery over 133 of the Nation's most populous and administratively important urban areas. In general, NGA provides most of the funding and the NGP brokers these funds with State and local government agencies, yielding a leverage of 70:1 for the NGP in 2009. The immediate Federal interest in these very high-resolution data is homeland security, public safety, emergency response, and other applications. The agencies plan a 2-to-4 year update cycle for each urban area.

For the rest of the Nation, the NGP collaborates annually with other Interior Bureaus and the Department of Agriculture in the National Agriculture Imagery Program to acquire one-meter resolution imagery. The imagery program acquires imagery for a third of the 48 States annually. The NGP funds one-half, and other Interior bureaus collectively fund the other half, of acquisition of coverage over Federally-managed lands; Agriculture agencies fund the acquisition for non-Federal lands. In return, the NGP receives coverage for all of the area for which imagery is acquired annually, yielding an approximate leverage of 15:1 for the NGP. These data are used by USGS science and other Interior programs that occur inside and outside of Federally-managed lands. In particular, the NGP uses these data as the default imagery component of *The National Map*, as the basis of the three-year maintenance cycle for the hydrography and other data categories. These data also provide the imagery component of the new US Topo map product.

Beginning in late 2010, the NGP will process orthoimagery data acquired through contracts or agreements with other Federal, State, and local government organizations using resources from the American Recovery and Reinvestment Act of 2009.

The NGP also will work with other organizations to develop options to obtain “leaf off” imagery for the eastern U.S. “Leaf off” imagery is captured before the start, or after the completion, of the growing season before plants sprout leaves. Users of products and services from *The National Map* who need to see features on the ground find “leaf off” imagery more helpful because vegetation does not obscure the ground. (In contrast, imagery from the National Agriculture Imagery Program is captured during the growing season, and so vegetation in the imagery has leaves (and so is “leaf on”). Such imagery is essential to farm programs in the Department of Agriculture, and is useful to users of NGP products and services in the western half of the Nation where vegetation is sparse or varies little among the seasons.)

National Elevation Dataset (NED) – *The National Map’*s elevation data theme is focused on data acquisition and quality assurance activities. A multi-resolution, seamless dataset (see Figure 1), The NED is updated on a quarterly basis as new source data become available, and overall accuracy is improved continually.

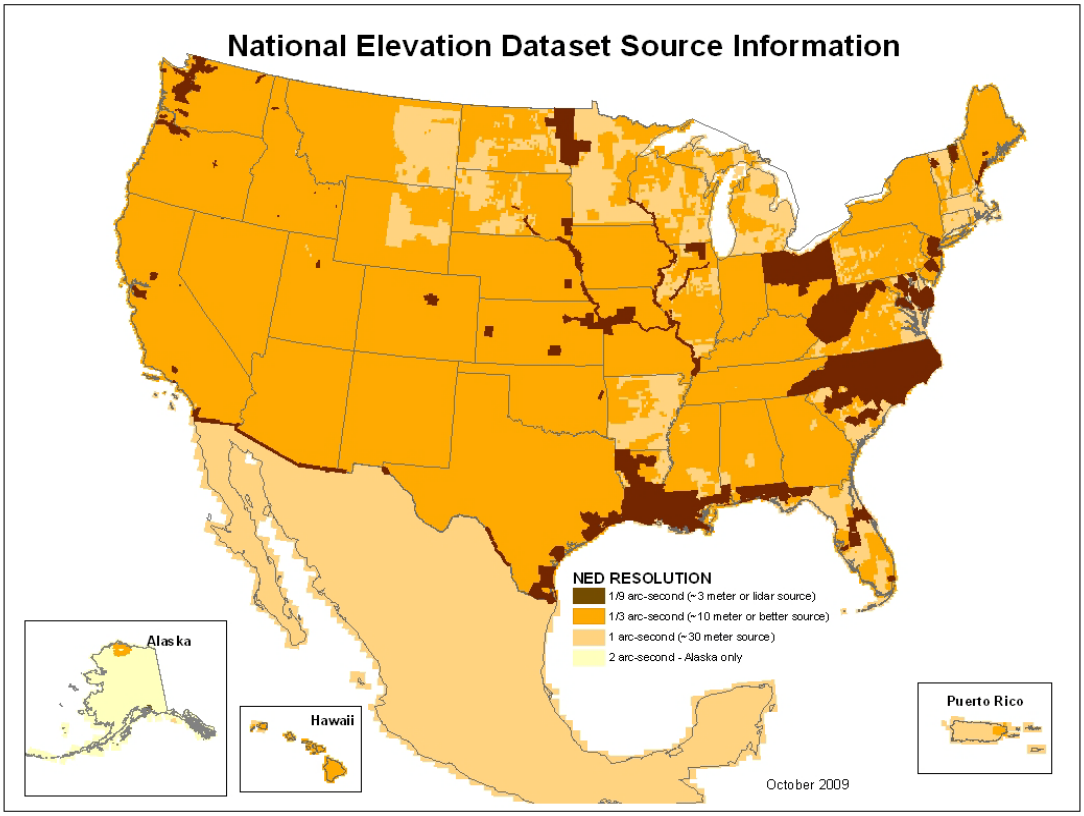

Figure 1. Quality of the National Elevation Dataset. The highest-quality data is shaded in dark, the least-high is shaded lightly. The NGP is completing the upgrade in the quality of data in the 48 States to the medium quality, and is using funds from the American Recovery and Reinvestment Act of 2009 (ARRA) to work with other organizations to upgrade elevation data to the highest quality in coastal and flood-prone areas.

Elevation data support emergency response and mitigation activities, and other priority Interior programs. These data support modeling of drainage networks and geometric correction of remotely sensed data that are critical to decision support systems (for example, flood mitigation and response and wildfire behavior prediction).

The growing demand for high-resolution elevation data over populated areas and flood plains drives current USGS investments in detailed elevation data and related technologies such as LiDAR and Interferometric synthetic aperture radar. The bureau is a founding member of the National Digital Elevation Program, a consortium of Federal and State agencies allied for the purpose of developing and maintaining national elevation data coverage in the public domain through cooperation among Federal, State, local, tribal, and private organizations. The elevation project acquires data through agreements with these organizations or through USGS contracts. The NGP quality assurance program guarantees that all new elevation data meets USGS quality specifications. The resulting data are archived and disseminated to the public via *The National Map*.

As part of the continual improvement of *The National Map*, in 2010 the NGP initiated an effort to ensure the compatibility of elevation and hydrography data. This effort ensures that the data are consistent (that is, the streams flow “down hill” as represented in the

elevation data). The result of this effort is consistency for customers who use both the elevation and hydrography data, and improved representation of both themes of data in the new US Topo topographic map product.

Beginning in late 2010, the NGP will process a large volume of very accurate elevation data acquired through contracts or agreements with other Federal, State, and local government organizations using resources from the ARRA.

The NGP is participating in the development of the National Digital Elevation Acquisition and Utilization plan, as required by House report to the 2010 Department of Homeland Security (DHS) appropriations bill. Due in the spring of 2010, the NGP anticipates that the report will lay out a national strategy for improved national elevation data coverage.

In 2009, the NGP leveraged its investment in elevation data with those of other Federal and State agencies, and received a return of 6:1 on average.

National Hydrography Dataset (NHD) and Watershed Boundaries – The NHD provides a complete nationwide data coverage for streams, lakes, and other surface waters of the Nation. Complementing these data are the watershed boundary data that delineate the land that drains to a set of streams. The NGP leads the multi-agency project to build and maintain this comprehensive geospatial dataset of the Nation's surface water to provide state-of-the-art analysis in water science.

This effort eliminates duplication of effort, improves the sharing of scientific data, and standardizes the technology to apply the data to business applications. The dataset is used by many agencies: USGS scientists in the bureau's StreamStats and SPARROW nutrient modeling projects; U.S. Forest Service in its Natural Resource Information System water module; Environmental Protection Agency as part of its Watershed Assessment, Tracking & Environmental Results system; Census Bureau in its map modernization activities; DHS in its ICWater program to assess risks in the Nation's surface water; and numerous State agencies for meeting reporting requirements of the Federal Water Pollution Control Act.

Beginning in 2010, the NGP undertook a three-year maintenance cycle for the completeness and positional accuracy of NHD data. Using the imagery obtained through the collaboration in the National Agriculture Imagery Program, the USGS compares the hydrography data to the imagery, and adds new streams and lakes and modifies those whose positions have changed. The NGP also is integrating into the NHD new, very accurately positioned hydrography data from the States of Iowa, Delaware, New Jersey, and Tennessee. It also is adding a few key structures, such as dams, gaging stations, and diversion structures, that are critical to users who model the flow of water. In 2009, the NGP leveraged its hydrography investment with those of other Federal and State agencies and received a return of 4:1 on average.

Geographic Names – The geographic names project is comprised of two functions: providing the Secretariat and staff for the United States Board on Geographic Names (BGN) and managing geographic names encoded in *The National Map*.

The BGN is an interagency body of representatives from Federal agencies. Authorized by Public Law 80-242, it issues standard geographic names for use on all materials (maps, documents, reports, data files) published by the Federal Government.

Geographic names are a critical reference component for scientific investigations and emergency response, as well as for land and resource management operations. Local, State, and Tribal agencies adhere to the guidelines and policies of the BGN and participate actively in the standardization effort. The BGN is also authorized to disseminate the official names and locations of cultural ("administrative") features, including schools, hospitals, and such emergency preparedness locations as police and fire stations.

The Geographic Names Information System (GNIS) is the authoritative database for all geographic names, which conform to the BGN's principles, policies, and procedures. The GNIS contains data from BGN decisions and from Federal agencies, State Names Authorities, State GIS offices, and Tribal authorities. It serves as the names layer of *The National Map*, and is a major component of the Geospatial One-Stop web portal. GNIS data elements are cited in the DHS Geospatial Data Model and the draft FGDC Address Standard.

In 2011, the USGS will continue to provide the BGN Secretariat national leadership responsibilities. The bureau will implement State stewardships as the model for geographic names harmonization across Federal, State, and local government and commercial products. With the completion of the integration of geographic names in its other databases, the NGP will ensure that all data in *The National Map* comply with BGN principles and policies.

For the remaining themes of data essential to users of *The National Map*, other Federal agencies have the lead coordination responsibility under OMB Circular A-16. Currently the NGP relies on other agencies to supply this information for use in *The National Map*.

Transportation – Transportation data, including roads, railroads, and airports, are critical to most geospatial applications that involve disaster response and mitigation, environmental planning, human health and infrastructure, and resource management, which are four major user communities for *The National Map*.

For roads, the NGP has worked with road data from the Census Bureau's TIGER modernization project. Because of problems found with these data, in 2010 the NGP plans to acquire a commercial road dataset for use in its US Topo product. In the meantime, the NGP is working with the Census Bureau to assess the TIGER data and plans for making corrections. It also is working with Federal agencies and other organizations to weigh options for obtaining in 2011 road data that is more usable and that can be shared openly and readily with users of products and services from *The National Map*.

The NGP is working with agencies of the Department of Transportation to seek sources of accurate and current data for railroads and airports. It also seeks to work with the results of an ongoing effort in the Interior to develop a database for trails, which are important to users who work in remote areas.

Boundaries – The boundary data theme depicts administrative and jurisdictional information critical to a broad range of applications, including those who require legal and ownership information. The boundary theme primarily relies on data from the Census Bureau, along with some boundaries of Federally-managed lands provided by other agencies.

Man-Made Structures – The structures data theme portrays buildings, industrial areas, facilities, and other features important to planners, land managers, utility companies, and the general public for a broad range of analyses and applications. These data include the locations of critical structures that are of vital interest to emergency responders.

In 2011, the USGS will continue to leverage data developed by the NGA, DHS and the States to complete additional National coverage of base data content in the public domain. It seeks to maintain these data through continuous updates from the States.

Topographic Maps: US Topo

At the celebration of the 125th anniversary of USGS topographic mapping on December 3, 2009, the USGS announced the "US Topo" topographic map product. The product is one of the many fruits of a more than decade-long effort to organize geospatial databases now included in *The National Map* and the related technical and organizational infrastructure needed to create, maintain, and publish these base geospatial data.

US Topo is the next generation of USGS topographic maps. Available on the web through *http://nationalmap.gov* and arranged in the traditional 7½-minute quadrangle format, digital US Topo maps are designed to look and feel like the traditional topographic maps. They add modern technical advantages that support wider and faster public distribution and enable basic, on-screen geographic analysis by all users. The files are used with software that reads Portable Document Format (pdf) files. Most computer users have such software, which is available for free on the Internet. Because all map information is contained in the US Topo map data files, they are especially useful to customers who work in the field or in other situations where the Internet is not available.

125 Years of USGS Topographic Mapping

On December 3, 2009, more than 300 people gathered at the USGS headquarters in Reston, Virginia, to celebrate the 125th anniversary of USGS topographic mapping. The event featured presentations about (1) the benefits of topographic map information, (2) the history of USGS topographic mapping, and (3) the announcements of the new US Topo digital topographic map, and method for viewing and accessing topographic information via the Internet. The last presenter, a USGS customer, emphasized the value and use of USGS topo maps and provided advice on future directions. The USGS made the first Henry Gannett award for distinguished contributions to topographic mapping and the Topographic Employee Recognition Award to honor the past, present, and future contributions of USGS employees, without whom there would be no wealth of topographic map information needed to meet challenges facing the Nation. For more information about the event, see http://nationalmap.gov/125years.

The creation and publication of the first series of primary USGS topographic maps occurred from the mid-1930's until the early 1990's, and required more than 35 million hours to complete 55,000 topographic maps for the 48 States. The average age of those maps is more than 30 years.

For the US Topo, the NGP plans to replace the current USGS topographic maps in the 48 States with US Topo maps over three years, and then revise each US Topo map every three years (see Figure 2). This feat is enabled by the three-year cycle of orthoimagery provided through cooperation with the National Agriculture Imagery Program and the continuous improvement programs being implemented for other data in *The National Map* that are discussed above. The US Topo builds on the investment in technique development made over the last two years, including a program of "beta" digital map production concluded in 2009 and earlier experiments to produce topographic maps for emergency responders in hurricane-prone areas of the southeastern United States.

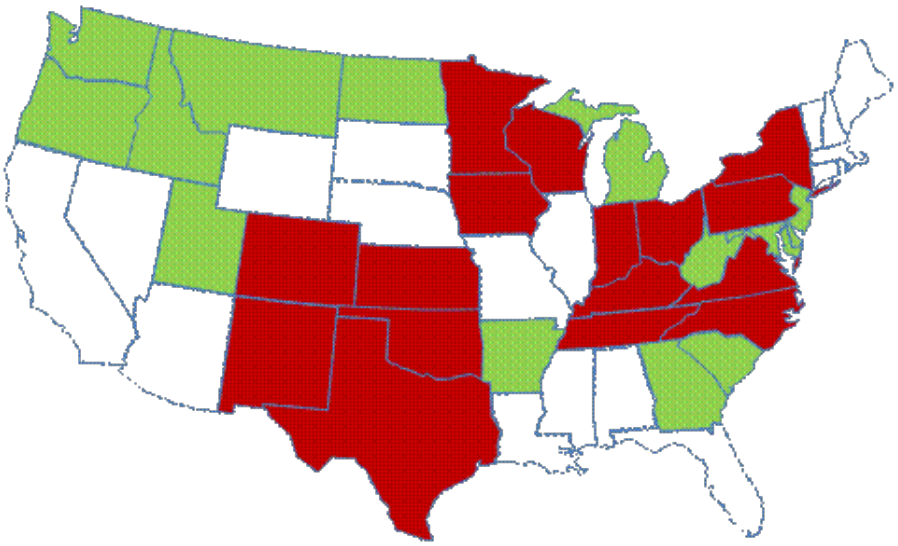

Figure 2. Three-year schedule for US Topo production. States with the red (or dark) shading are scheduled for 2010, with green (or light) shading for 2011, and with no shading for 2012.

The States of Hawaii and Alaska, and the U.S. commonwealths and territories, are special challenges for which the NGP is developing a strategy for US Topo coverage. The National Agriculture Imagery Program includes neither State and so alternate sources of orthoimagery are required.

Data Access

The NGP ensures that public domain geospatial data associated with the eight major themes and US Topo map products prepared from these data are freely accessible continually to customers, cooperators, and the public. The goal of the data access activities is to ensure that products and services are provided in a way that Federal agency customers and others can incorporate the information in their decision making and operational systems with minimal effort required on their part. The NGP accomplishes this goal by providing methods to download (obtain a copy of) data, to access the data through industry-standard Internet map services, and to use NGP-provided methods of viewing *The National Map* and combining it with their business data. Third parties that provide map services over the Internet, such as Google and Microsoft, also incorporate data from *The National Map* in their products and services, providing a fourth method to access this information.

In 2010, the NGP released a new map viewer for *The National Map* (see Figure 3). The new software, available as a beta release at *http://nationalmap.gov*, provides one-stop preview and download of topographic data, and access to web map services and US Topo maps over the Internet. Features include (1) maps images developed by the USGS; (2) the ability to use data in other map viewers and GIS software such as the Google Maps™ mapping system, Bing maps, and ESRI® ArcMAP™; (3) simple methods to “mash-up” (combine) *The National Map* with other services; and (4) tools to obtain more information for features portrayed on the maps, change coordinate systems, measure lengths and areas, and make and share annotations. The USGS developed the viewer in a partnership with NGA and with input from USGS stakeholders.

In response to demand for historical map information for use in scientific studies of change on the landscape, the NGP is digitally scanning its archive of topographic maps and encoding them so they can be overlaid with other map data. It also is scanning records of more than a century of decisions about geographic names. The resulting information will be made available on the

Internet, providing access to a wealth of information that previously was available only by visiting the USGS headquarters in Reston, Virginia or selected libraries.

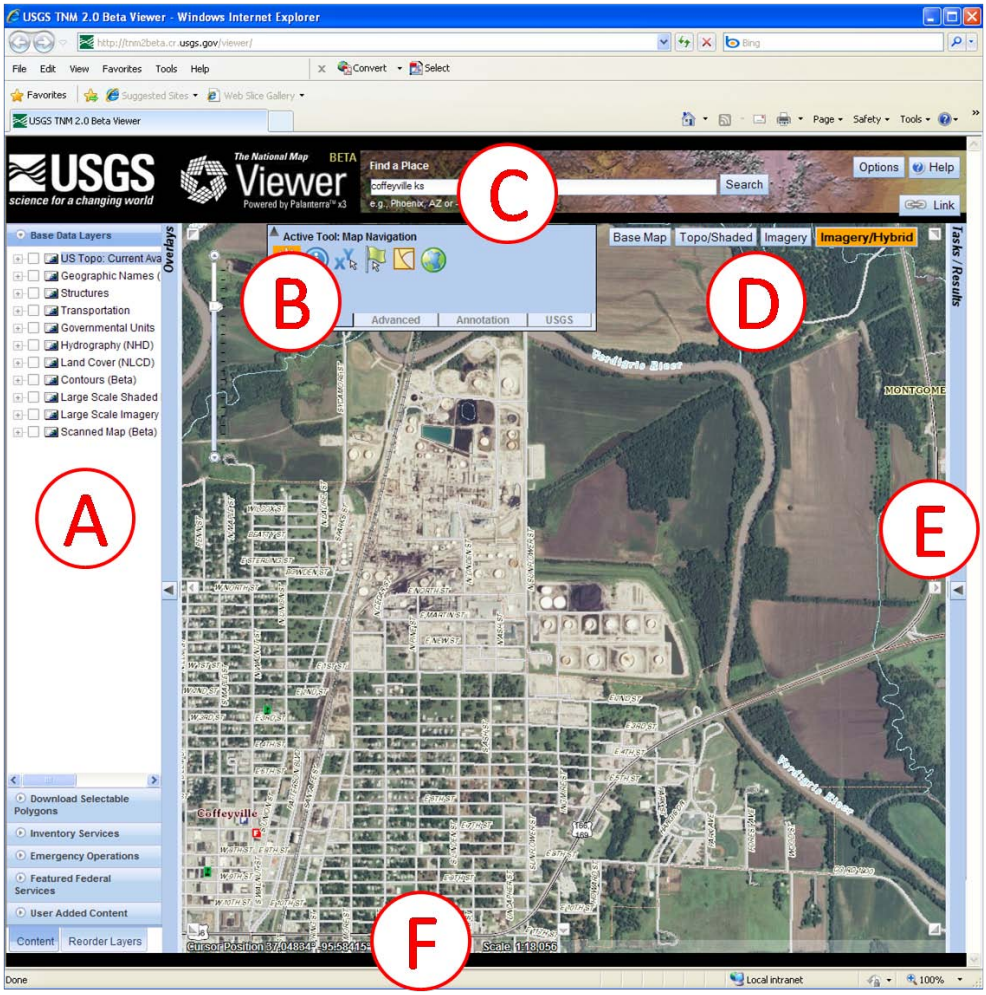

Figure 3. The viewer for *The National Map* showing imagery and topographic map data for Coffeyville, Kansas. Features of the viewer include (see area A) the ability to choose data overlays for display and download, (B) tools to get more information or measure distances and areas, (C) zoom to a place, (D) change map displays with one click, (E) open the display to show the results of tasks, and (F) readouts of coordinates and map scale.

In 2011, the USGS will continue to improve and refine the delivery of data, products, and web services for *The National Map* through *The National Map* viewer. The USGS will retire several old Internet portals and map viewers as the new viewer matures and assumes the roles played by the older systems. The USGS will also continue to improve the performance of *The National Map* viewer and improve the ability to use data from *The National Map* with commercial software such as the Google Earth™ and Google Map™ mapping systems and Bing maps.

Geospatial Data Archive

The USGS archives geospatial data and metadata to maintain original data sets such as high-resolution orthoimagery quadrangles, digital raster graphics, digital line graphs, and digital elevation information. The USGS makes archived information available online in time frames that allow them to be used in emergency response activities as well as ensuring long-term preservation.

In 2011, the USGS will continue to maintain the archive of materials and support the growth of the archive as new NGP geospatial data are acquired. Planned activities include data organization, ingest, metadata generation, data set appraisals and assessments, dispositions including transfer to the NARA, and preservation activities such as data set transcriptions and media migrations for offsite storage and protection. These activities occur at the USGS EROS in Sioux Falls, South Dakota.

Geospatial One-Stop

The NGP manages the GOS Web portal, one of OMB's electronic government initiatives. The portal, located at *http://www.geodata*.gov, serves as the government's gateway for the discovery and access to the Nation's distributed geospatial resources from thousands of organizations across the country. Geospatial data sets, Internet mapping services, models, applications, and place-based publications catalogued in the portal are developed by local, Tribal, State, and Federal Government organizations, academia, and the private sector. Customers search, discover, and access these items using the portal.

In 2010, the NGP is investing in changes to improve the stability and reliability of the GOS portal, especially those aspects needed to support interactions with Data.gov.

In 2011, the NGP will continue to enhance the interaction between the GOS portal, *The National Map*, and the geospatial component of Data.gov to incorporate data and services from Federal, State, local and Tribal sources. The NGP also will improve the search capability to enhance the discovery of Agency "authoritative" data services and provide geospatial content to many other applications. It will support new industry standards that improve the ease with which customers can use geospatial data.

The NGP also anticipates that it will procure a replacement for the current portal. This "GOS version 3.0," developed in cooperation with the members of the Federal Geographic Data Committee and the staff for Data.gov, will help users view geospatial data from a variety of sources, allow them to access these data, and provide a "national catalog" of geospatial data to help users find available data and reduce duplication of effort.

National Geospatial Technical Operations Center

The National Geospatial Technical Operations Center (Center) is the main operational component of the NGP, *The National Map*, and *The National Atlas of the United States of America*®. It develops and enhances the usefulness of national geospatial products and services; acquires new geospatial data from the private sector; and receives, performs quality assurance, and incorporates into *The National Map* data procured under contract and delivered by cooperators. It also improves public access to this information through online data viewing and download through its support of the new viewer for *The National Map*.

In 2009, the Center completed a multiyear organizational re-engineering effort. The Center designed and established a single, streamlined organizational structure that spans two physical locations in Denver, Colorado and Rolla, Missouri.

In 2010 and 2011, the Center will perform the operations needed to undertake the receipt, quality assurance, integration, and dissemination of improved information in *The National Map* described above, and the operations of The National Atlas of the United States of America® described below.

The National Atlas of the United States of America®

(Estimates for 2009, $2.7 million; 2010, $2.6 million; 2011, $2.5 million)

The National of the United States of America® (*http://www.nationalatlas.gov*), the small-scale component of *The National Map*, features products and services designed to make geographic information available to a broad audience. For the public, the Atlas produces wall maps; polished page-size maps; multimedia articles on the Nation's natural and socioeconomic resources; dynamic maps that illustrate change over time; and an innovative and award-winning interactive map maker that includes more than 2,500 map layers. For professional users, *The National Atlas* provides accurate, integrated geospatial data; full documentation for these data; and Web map services.

Working with sister agencies in Canada and Mexico, the NGP developed the *North American Environmental Atlas* to help users understand continental-scale environmental issues. For example, a pollutant mapping tool in the Google Earth™ mapping system allows users to explore information for more than 30,000 facilities across the U.S., Canada, and Mexico. The Atlas also offers basic cartographic and environmental data for the continent at no cost.

The NGP is replacing the base data layers of the Atlas. The new data, derived from data from *The National Map* and other sources, will provide more detailed information than was provided by the Atlas previously. The new data are designed for use in the Global Map, an effort by national mapping organizations around the world to produce standard maps for the Earth. As a result, base data from *The National Atlas* will be readily compatible with those for neighboring nations, an important feature for Federal agencies and other customers that deal with issues that span the borders of the U.S.

Center of Excellence for Geographic Information Science

(Estimates for 2009, $2.0 million; 2010, $2.0 million; 2011, $2.0 million)

The Center conducts, sponsors, and collaborates on research to find innovative solutions needed for *The National Map*, the NSDI, and the emerging Geospatial Web.

In 2010 and 2011, the focus of CEGIS is to continue implementing recommendations from the National Research Council (NRC) report "A Research Agenda for Geographic Information Science at the United States Geological Survey." These activities include using post-doctoral scientists and academic contracts to discover the research answers needed to support *The National Map*. The CEGIS has active research projects in the following areas recommended by NRC: the design of an electronic topographic map and user-centered design for web-map interfaces, which the NGP will use to improve the utility of the US Topo and viewer for *The National Map.* A project for automated data integration, generalization, and multi-resolution raster data will inform efforts to improve the ability of NGP to maintain the data in *The National Map*. A project that develops an ontology for *The National Map* anticipates developments in the way geospatial data are used on the Internet and helps the NGP position its products and services for the future. The Center also is investigating the extent to which "crowd-sourced" data (data from citizens with GPS-enabled cell phones and other devices) can complement other efforts to maintain the currentness and improve the quality of data in *The National Map*.

Emergency Operations

(Estimates for 2009, $3.6 million; 2010, $3.5 million; 2011, $3.4 million)

The focus of Emergency Operations is for the NGP to provide coordination and support to geospatial information activities associated with emergency response for natural and human-made disasters, homeland security and defense, law enforcement, and the intelligence communities. A secondary role is to facilitate, where appropriate, the analysis needs of these communities with other USGS science disciplines.

Emergency Operations activities promote the adoption of the NGP as the underpinning for Federal mapping activities that support public and private sector organizations with homeland security and defense, law enforcement, and emergency management mission responsibilities.

Activities in 2010 and 2011 include partnership development, liaison, and coordination; information requirements definition; inter-bureau and discipline coordination; geospatial applications development and support; support for USGS continuity of government and continuity of operations responsibilities; national security special events support; emergency response support; custom and special product generation; and provision of sensitive, proprietary, and classified information. These activities enable the use of government assets for many purposes, and so improve the value of these data and services to citizens. Key Federal partners and stakeholders include Interior, the DHS, U.S. Marshals Service, NGA, United States Northern Command, and the National Guard Bureau among others.

Partnership Implementation

(Estimates for 2009, $13.5 million; 2010, $13.9 million; 2011, $10.4 million)

The Partnership Implementation component funds cooperative work with Federal, State, and local government organizations and the network of geospatial liaison personnel that develop agreements to share resources and funding with cooperators.

NGP cooperative arrangements are the main method through which the NGP obtains information to maintain the currentness and improve the quality of *The National* Map leveraging funding across Federal, State, and local government organizations to provide cost savings. The NGP cultivates long-term relationships with cooperators and develops agreements for stewardship and maintenance of the data content of *The National Map,* GOS, and other projects. In the past several years, leveraging has yielded approximately eight to ten dollars for every dollar invested.

The partnership network is comprised of headquarters- and regionally-based liaisons who coordinate with other Federal agencies and national organizations, and State-based geospatial liaisons who work with geospatial communities in the States. As the “eyes and ears” of the NGP, they develop agreements with cooperators, provide support to customers, and receive new requirements.

In 2010, the NGP is executing a competitive announcement to select cooperators with which to develop detailed elevation and orthoimagery data funded by The Recovery Act to identify opportunities and make arrangements to cooperate with other Federal, State, and local government organizations

In 2011, Partnership Implementation activities will focus on the following efforts:

- Define stakeholder strategies and staffing to meet the goals of the NGP Strategic Plan. Focus will be given to communities interested in data theme and product priorities identified in the plan;
- Continue to improve communications materials and outreach for *The National Map*; and,
- Working with the FGDC-OS, provide mechanisms for systematic input by Federal agencies to *The National Map* and other NGP products. Strengthen engagement of other Federal agencies in NGP products and services as a foundational element of NSDI.

Federal Geographic Data Committee Office of the Secretariat (FGDC-OS)
(Estimates for 2009, $5.9 million; 2010, $5.8 million; 2011, $5.8 million)

The FGDC-OS of the USGS provides executive support to the FGDC. Established by OMB Circular A-16, the FGDC promotes and promulgates consistent data and metadata standards, system interoperability, and cross-government best business practices for geospatial resources, policies, standards, and technology. The FGDC is charged with facilitating the building of the NSDI.

The FGDC-OS coordinates, develops, and manages the geospatial data clearinghouse, accessible through the GOS web portal, which provides for the discovery of and access to geospatial data.

Federal Geographic Data Committee Executive Support
The FGDC is the coordinating body for activities related to development of the NSDI and coordinates the development, use, sharing, and dissemination of geospatial data on a national basis. The NSDI is the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data. It is a physical, organizational, and virtual network designed to enable the development and sharing of the Nation's digital geographic information resources.

The FGDC-OS provides leadership, support, outreach, and technical- and subject-matter expertise to the FGDC. These responsibilities include support to the FGDC Executive Committee, Steering Committee, and Coordination Group; the National Geospatial Advisory Committee (NGAC); and numerous thematic subcommittees and cross-cutting working groups (which deal with broader issues such as clearinghouse, architecture and technology, metadata, and standards). The FGDC-OS is the hub that coordinates efforts among the various committee activities, and facilitates the identification of national geospatial issues and coordination opportunities. It manages and maintains the FGDC web site and associated content, documents, news releases, and committee, subcommittee, and work group pages.

In 2011, the FGDC-OS will manage coordination activities; participate in Federal, State, and international geospatial standards, coordination, and infrastructure development committees and consortia; coordinate the development of FGDC geospatial standards; and develop training and outreach materials.

It also will provide leadership and manage several activities that encourage the development of the NSDI that are listed below.

Geospatial Line of Business
The FGDC-OS provides leadership and support for the Geospatial Line of Business (GeoLoB). GeoLoB is an initiative in the President's E-Government objectives to develop a more strategic, coordinated, and leveraged approach to producing, maintaining, and using geospatial data and services across the Federal Government. The vision is to serve vital national interests and the core missions of Federal agencies and their partners through the effective and efficient provision of geospatial data and services.

Fifty States Initiative
The FGDC-OS manages the Fifty States Initiative, which supports a goal of the USGS to engage all levels of geospatial data and information providers and practitioners in the creation of the NSDI. The Fifty States Initiative engages all States in the task of developing the NSDI by supporting their leadership in coordinating among all geospatial users and providers within their respective States.

The initiative supports the States in their development and implementation of Statewide strategic and business plans. Such plans facilitate the coordination of programs, policies, technologies, and resources that enable the coordination, collection, documentation, discovery, distribution, exchange, and maintenance of geospatial information in support of NSDI. The FGDC-OS works closely with the National States Geographic Information Council to advance this initiative.

In 2011, the FGDC-OS will evaluate the next phase of this initiative. In particular, the focus likely will shift from planning to implementation activities.

NSDI Cooperative Agreements Project
Since 1994, the NSDI Cooperative Agreements Project (CAP) has played a significant role in promoting and disseminating the tenets of NSDI to thousands of NSDI advocates and practitioners. Managed by the FGDC-OS, the program develops incentives for agencies and organizations to participate in the NSDI. To date, NSDI CAP awards have created collaborations at all levels of government, developed an understanding of geospatial information in organizations and disciplines new to the NSDI, provided seed money for cost-shared projects to enable geospatial organizations to participate in the national effort to implement NSDI, promoted the development of standardized metadata in hundreds of organizations, and funded numerous implementations of new industry standards developed by the Open Geospatial Consortium.

National Geospatial Advisory Committee
Another goal of FGDC is to facilitate collaboration among Federal geospatial user and provider partners at the national level. The NGAC was created to provide advice from a representative sample of the Nation's geospatial community to the Federal Government on the management of Federal geospatial programs, the development of the NSDI, and the implementation of OMB Circular A-16. The NGAC is sponsored by Interior under the Federal Advisory Committee Act. It provides advice and recommendations to FGDC through the FGDC Chair (the Secretary of the Interior or designee) on behalf of FGDC member agencies. The NGAC complements other

> *"I am writing this letter today to express my sincere appreciation for the superior support provided to me by your staff in my duties as the Chair of the National Geospatial Advisory Committee. Your staff has been very helpful, always timely and exceedingly thorough in support of the Committee."*
>
> Anne Hale Miglarese
> Chair, National Geospatial Advisory Committee
> July 17, 2009

FGDC efforts to engage States, counties, communities, NGOs, academia, and industry in its activities. The FGDC-OS supports the NGAC and serves as its Designated Federal Official.

Geospatial Data Clearinghouse
The FGDC-OS coordinates the sharing of geographic data, maps, and online services through the NSDI clearinghouse, a network and supported search capability managed, monitored, enhanced, and developed by the FGDC-OS. The clearinghouse network is a resource accessed by the GOS web portal; the portal searches metadata held within the NSDI Clearinghouse Network to enable users to identify and analyze available geospatial data. The FGDC-OS also provides support to the Data.gov website development team, helping them leverage the capabilities and geospatial tools developed through the GOS efforts.

International Activities
The FGDC facilitates the building of the NSDI while also promoting the creation of spatial data infrastructures (SDI) globally. This support occurs mainly through conference attendance, outreach, and participation in and leadership of technical work groups, and participation in international geospatial bodies and events. The conferences provide opportunities for geospatial experts and policymakers at local, regional, and global levels to interact for the purpose of determining how SDI developments can help address important worldwide needs.

Geospatial Standards Development
The FGDC-OS develops geospatial data standards for implementing the NSDI**,** in consultation and cooperation with State, local, and Tribal governments, the private sector and academic community, and, to the extent feasible, the international community. It develops geospatial data standards only when no equivalent voluntary consensus standards exist, in accordance with OMB Circular A-119. The FGDC-OS leads the FGDC Standards Working Group and promotes and coordinates FGDC standards activities. It maintains membership in the International Committee for Information Technology Standards Technical Committee L1 on Geographic Information and serves as a conduit between the committee and the broader Federal community.

Performance Overview

The following table highlights important performance measures for the National Geospatial Program Subactivity.

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of surface area of the conterminous U.S. for which high-resolution geospatial datasets are cataloged, managed, and available through *The National Map* **(SP) (NGP)**	C	UNK	99.71% (698/700)	99.86% (699/700)	99.86% (699/700)	99.86% (699/700)	100% (700/700)	100% (700/700)	0	100% (700/700)
Comment	The National Geospatial Program continues to maintain the geospatial data layers over the conterminous US. There are 7 data layers to maintain.									
Square miles of high resolution elevation data collected in Priority Areas and added to the 1/9 arc-second (3 meter) National Elevation Dataset (NED) **(NGP) (Base Funds)**	A	NA	NA	93,153	58,000	66,000	58,000	29,000	-29,000	29,000
Comment	The proposed reduction to *The National Map* partnerships program results in a decrease in performance.									
Square miles of high resolution, leaf off (<1m) orthoimagery data collected in the US and its territories added to the NGP orthoimagery database **(NGP) (Base Funds)**	A	UNK	UNK	79,751.35	75,000	253,192	200,000	75,000	-125,000	75,000
Comment	The proposed reduction to *The National Map* partnerships program results in a decrease in performance.									

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Square miles of the US with updated high resolution elevation data **(NGP) (ARRA)**	A	UNK	UNK	UNK	58,000	92,000	58,000	58,000	0	58,000
Comment	Performance is impacted in 2009 by ARRA funding. Not a cumulative measure.									
Square miles of the US with high resolution, leaf off, <1m imagery data **(NGP) (ARRA)**	A	UNK	UNK	79,751	75,000	1,346,692	200,000 *	200,000	0	200,000
Comment	Performance will be impacted by ARRA funding. Not a cumulative measure. * Increase due to Nat'l Geospatial Intelligence Agency Border Program.									
% of total cost FSA and USGS saved through partnering with other entities for imagery acquisition of 1-meter NAIP orthoimagery (NGP)	A	41% (4.43/10.8)	32% (2.3/7.2)	27%	36% (5.0/14.0)	18% (4.3/23.8)	40% (5.6/14)	0	-40%	0
Comment	The proposed reduction to *The National Map* partnerships program results in a decrease in performance.									
% of customers that identify or indicate (via a survey) that USGS NGP Outreach materials and activities (information and publications, conferences, training and workshops) met their needs/ requirements **(NGP)**	C	UNK	UNK	20%	20%	UNK	Baseline	30%	0	30%
Comment	In 2010, this measure was rebaselined to determine the number of customers. The percent of customers is expected to increase in 2011 based on 2010 results.									
% of NGP partners reporting satisfaction with partnership agreements **(NGP)**	C	UNK	UNK	75%	75%	UNK	Baseline	80%	0	80%

Geologic Hazards, Resources, and Processes

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Geologic Hazard Assessments ($000)	90,585	44,655	92,763	-1,643	1,800	92,920	+157
FTE	*440*	*0*	*438*	*-4*	*+5*	*439*	*+1*
Geologic Landscape and Coastal Assessments ($000)	72,381	0	74,351	-1,266	+4,500	77,585	+3,234
FTE	*359*	*0*	*358*	*-3*	*+8*	*363*	*+5*
Geologic Resource Assessments ($000)	79,176	0	82,017	-1,289	+2,600	83,328	+1,311
FTE	*496*	*0*	*495*	*-5*	*+5*	*495*	*0*
Total Requirements ($000)	242,142	44,655	249,131	-4,198	+8,900	253,833	+4,702
Total FTE	*1,295*	*0*	*1,291*	*-12*	*+18*	*1,297*	*+6*

1) $3,123 in fixed costs is absorbed ($987 in Geologic Hazard Assessments, $795 in Geologic Landscape and Coastal Assessments, and $1,341 in Geologic Resource Assessments).

2) See the General Statement and Section G for Details on DOI-wide Changes.

3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Activity Summary

The 2011 budget request for the Geologic Hazards, Resources, and Processes Activity (Geology Discipline) is $253,833,000 and 1,297 FTE, which is a net program change of +$8,900,000 and +18 FTE from the 2010 Enacted level. Additional information on program changes is provided in each subactivity section and in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

The budget request includes proposed increases of +$1.8 million to the Earthquake Hazards Program (EHP) for funds for Increasing Resilience to Natural Hazards; +$1.5 million to the Volcano Hazards Program (VHP) for funds for Increasing Resilience to Natural Hazards; +$500,000 to the National Cooperative Geologic Mapping Program (NCGMP) for support to the Water Conservation Initiative; +4.0 million to the Coastal and Marine Geology Program (CMGP) for funds for Marine Spatial Planning; +$250,000 to the Mineral Resources Program (MRP) for funds to support to Increasing Resilience to Natural Hazards; and +3.0 million to the Energy Resources Program (ERP) for funds to continue work as part of the New Energy Frontier- Wind Initiative.

The budget request includes proposed decreases of -$1.0 million from the EHP to eliminate unrequested congressional funding for Light Detecting and Ranging (LiDAR) and seismology studies; -$250,000 from the VHP to eliminate unrequested congressional funding for support a cooperative partnership between the University of Hawaii-Manoa and the USGS Hawaii Volcano Observatory; and -$650,000 from the MRP to eliminate unrequested congressional funding for a mineral resource assessment of Federal lands in Nye County, Nevada.

The Geology Discipline Programs provide Earth science information needs for a wide variety of partners and customers, including Federal, State, and local agencies, non-government organizations, industry, and academia. This information is used by the USGS and its partners,

cooperators, and customers in evaluating resource potential, defining and mitigating risks associated with natural hazards, and characterizing the potential impact of natural geologic processes on human activity, health, the economy, and the environment.

The mission of the Geology Programs contributes to the achievement of providing for responsible resource protection and use and serving communities by providing information to improve the understanding of national ecosystems and resources through integrated interdisciplinary assessment; to improve the understanding of energy and mineral resources to promote responsible use and sustain the Nation's dynamic economy, and to improve understanding, prediction, warning and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property All Geology programs have a 5-Year Plan that supports the USGS Science Strategy and is reviewed every 5 years.

Other Program Reviews

During 2009, the ERP had its reserve growth methods reviewed by the American Association of Petroleum Geologists (AAPG), Committee on Resource Evaluation (CORE). Based on the recommendations of the outside peer-panel review, USGS has revised its methodology and in the future will be providing probabilistic estimates of reserve growth. Currently, the AAPG CORE is reviewing the ERP methodology for economic analysis of continuous-type resources. The ERP just completed an external, technical, peer review of its newly developed methodology to assess the Nation’s resources for geologic carbon sequestration in oil and gas reservoirs and saline formations. The ERP also participates in the review of other agency's programs and has recently participated in the National Research Council review of DOE's gas hydrates program. USGS has a robust gas hydrates program and is part of every major research effort in the U.S.

Using guidance developed by the National Academy Committee on Critical Minerals published in 2008, the MRP has identified 16 mineral commodities as the focus of the next National Mineral Resource Assessment including metals and rare earth elements needed for new energy and "green" technology development as well as industrial minerals important to agriculture. Development of new mineral deposit and mineral environmental models for these commodities is scheduled for completion in FY 2013.

The American Association for the Advancement of Science (AAAS) 2006 review of the National Cooperative Geologic Mapping Program recommended that the USGS "set standards for data collection, preservation, and exchange." As a result, the program led the creation of the recently released Federal Geographic Data Committee (FGDC) approved Map Symbol Standard that has since been adopted by Environmental Systems Research Institute (ESRI), an industry leader in geographic information system technology. In 2009, the program released for review to the geologic mapping community “NGCPMP09”, a proposed standard format for geologic map publications.

The Scientific Earthquake Studies Advisory Committee, established by Congress in the 2000 reauthorization of the National Earthquake Hazards Reduction Program (NEHRP), reviews the Earthquake Hazards Program on an annual basis. In response to the most recent committee recommendations, the USGS is: investing more heavily in the Advanced National Seismic System (ANSS); nurturing and expanding multi-hazards projects in southern California and the Pacific Northwest; developing plans for the USGS role in geodetic research and monitoring and understanding episodic tremor and slip events; as well as continuing to support advances in earthquake early warning.

The 2007 review of the VHP conducted by the AAAS strongly endorsed implementing the National Volcano Early Warning System (NVEWS), and proposed that the VHP work more closely with State and local partners in developing risk-focused products that deal with future eruption scenarios. From 2008-2009 an implementation plan and instrumentation plan for NVEWS was completed and NVEWS was used as the blueprint for modernizing the volcano monitoring system as part of the American Recovery and Reinvestment Act. Also in 2009, the USGS strengthened existing volcano partnerships with the Universities of Washington and Utah, and created new partnerships with the state of Wyoming and the University of Hawaii at Manoa.

Workforce Planning

The Geology Discipline implemented a workforce planning strategy in 2005 aligned with the USGS science goals and tied to Government Performance and Results Act (GPRA) goals. The plan identified areas in which the USGS needs to build internal capacity, contract with the private sector, and partner with other organizations; forecast future critical skill needs and identify mechanisms for recruiting, developing, and retaining a diverse workforce with those critical skills; align individual employee performance and rewards with organizational performance; and make effective use of technology. The Regions led an effort during 2009 to update the workforce strategy and implement voluntary early retirement and separation actions in several critical areas including the Western Region Hazards Science Center and the Central Region Mineral Resources Science Center. The Geology Discipline is working with regional line management, to support its efforts to continue to rebalance and renew the skill mix to gain functional and position flexibilities.

Subactivity Overview

The Geologic Hazards, Resources, and Processes Activity is comprised of three subactivities:

Geologic Hazard Assessments programs operate monitoring networks, provide hazard warnings, assessments, and evaluation of impacts, and work with emergency managers and decisionmakers to develop response strategies and mitigate damage and loss. Programs include EHP, VHP, Landslide Hazards Program (LHP), Global Seismographic Network (GSN), and Geomagnetism.

Geologic Landscape and Coastal Assessments programs focus on understanding geologic processes at or near the Earth's surface. Knowledge and models derived from these studies enable more effective, adaptive, and efficient resource and environmental management decisions. Programs include CMGP and NCGMP.

Geologic Resource Assessments programs assess the availability and quality of the Nation's mineral and energy resources, including the economic and environmental effects of resource extraction and use. Programs include the MRP and the ERP. The MRP is the Federal provider of scientific information for objective resource assessments and research results on mineral potential, production, consumption, and environmental effects, and also provides comprehensive baseline data in the fields of geochemistry, geophysics, and mineral deposits.

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Activity: Geologic Hazards, Resources and Processes

Subactivity: **Geologic Hazard Assessments**
Program Component: **Earthquake Hazards**

	2009 Enacted	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1,2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Earthquake Hazards Program ($000)	55,760	0	57,021	-930	+800	56,891	-130
Total FTE	*248*	*0*	*247*	*-3*	*+3*	*247*	*0*

1) $545 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Earthquake Hazards Program

Request Component	($000)	FTE
• Increasing Resilience to Natural Hazards	+ 1,800	+ 3
• LiDAR and Seismological Studies	-1,000	0
TOTAL Program Changes	**+ 800**	**+ 3**

Justification of 2011 Program Changes

The 2011 budget request for the Earthquake Hazards Program (EHP) is $56,891,000 and 247 FTE, a program change of +$800,000 and +3 FTE from the 2010 Enacted level.

Increasing Resilience to Natural Hazards **(+$1,800,000 / 3 FTE)**

This effort will increase the Nation's resilience to natural hazards by continuing the Multi-Hazards Demonstration Project (MHDP) in Southern California in its fifth year in 2011 and expanding efforts in the Pacific Northwest, and Alaska coastal communities. The USGS hazard programs are heavily integrated into regional hazard planning and mitigation activities to address multiple hazards in both Oregon and Washington. Expanding the multi-hazards demonstration project approach in Alaska would improve the ability of the USGS to support emergency planning and risk assessment of potential future hazards at and near the coastal population centers and would invest in earthquake, tsunami, and volcano science to support community planning in Alaska. to the requested increase in funding for the EHP would build on the success of the Great Southern California ShakeOut by developing enhanced earthquake forecasting and prototype early warning capabilities, working with partners and critical users in southern California. This initiative proposes to improve seismic monitoring capabilities in the Pacific Northwest with deployment of low-cost strong-motion sensors in high-hazard urban

areas. In Alaska, the initiative would support development of a catalog of tsunami-generating earthquake sources along the southern and southeastern Alaska margin for use in both earthquake and tsunami hazard assessments to support community preparedness. Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

LiDAR and Seismological Studies (-$1,000,000 / 0 FTE)

The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of available resources. “This general funding increase in 2010 was used to support LiDAR acquisition in high-hazard areas of the Pacific Northwest as well as seismic hazard investigations in areas of the Pacific Northwest and Southern California with high earthquake risk and community danger.” This support activity will be discontinued in 2011.

Program Overview

Of all natural hazards facing the United States, earthquakes have the greatest potential for inflicting catastrophic casualties, damage, economic loss, and disruption. Damaging earthquakes are infrequent, but their consequences can be immense. According to recent studies, a major earthquake in an urbanized region of the United States could cause several thousand deaths and a quarter trillion dollars in losses. Although the risk from earthquakes is high in California, many other parts of the country are also at risk, including the Mississippi River valley, Pacific Northwest, Intermountain West, Alaska, Hawaii, and parts of the eastern seaboard. Over 75 million people, including 46 million outside California, live in metropolitan areas with significant earthquake risk.

An Overview:

Earthquake Hazards Program

- As required under the Disaster Relief Act of 1974 (P.L. 92–288), the USGS has the delegated Federal responsibility for monitoring and notification of seismic activity in the United States. The USGS is the only U.S. agency that routinely and continuously reports on current domestic and worldwide earthquake activity.
- Provides the scientific information and knowledge necessary to reduce deaths, injuries, and economic losses from earthquakes and earthquake-induced tsunamis, landslides and liquefaction.
- Products of this program include timely notifications of earthquake locations, size, and potential impacts; regional and national assessments of earthquake hazards; and public outreach to communicate advances in understanding earthquakes, their effects, and the degree to which they can be predicted.

Through the ANSS, the USGS and its State and university partners provide seismic monitoring coverage for the Nation. The EHP is the applied earth science component of the four-agency NEHRP, most recently re-authorized by the Earthquake Hazards Reduction Authorization Act of 2004 (P.L. 108–360); a re-authorization bill is currently under consideration in Congress. Through NEHRP, the USGS partners with lead agency National Institute of Standards and Technology (NIST), the Federal Emergency Management Agency (FEMA), and the National Science Foundation (NSF).

Partnerships are crucial to the program's success. Approximately 25 percent of the total EHP budget is directed toward research grants and cooperative agreements with universities, State agencies, and private technical firms to support research and monitoring activities. This external funding is highly leveraged by funds from other Federal agencies, States, and the private sector.

USGS rapid information and analysis aids Haiti response

Immediately following the magnitude 7 earthquake struck Haiti on January 12, 2010, the USGS began providing critical science information to federal partners, emergency responders, policy makers, and the media regarding the earthquake, its impacts and its subsequent aftershocks. Less than 25 minutes after the earthquake struck, the USGS National Earthquake Information Center released its estimate of affected population to aid agencies and other critical users, providing situational awareness ahead of news reports. USGS earthquake and landslide experts analyzed optical and radar imagery to assess the location and extent of fault rupture, and to identify landslides that could block drainages posing flash-flood risks downstream. The USGS also issued a formal statement on Earthquake Hazard and Safety in Haiti and the Caribbean Region; prepared by a team of USGS earthquake experts, the statement addressed the ongoing threat of aftershocks and the small potential for an additional magnitude-7 earthquake striking the area. In the two weeks following the initial earthquake, aftershocks of between 4.5 and 5.9 greater have been measured .

Overall direction for the EHP is established by a 5-Year Plan that results from internal and external inputs. These inputs include the USGS and Interior strategic plans, results of periodic reviews by the congressionally established external Scientific Earthquake Studies Advisory Committee, workshops with stakeholders on specific topics, and the advice of senior scientists both within and outside the USGS. The program is a critical component of the national hazards, risk and resilience assessment activity called for in the USGS Science Strategy document, *Facing Tomorrow's Challenges*. The program's activities are identified in the National Science and Technology Council's planning documents, including the Subcommittee on Disaster Reduction's (SDR) *Grand Challenges for Disaster Reduction* (2005), an earthquake-specific implementation plan (2008), and the joint SDR/U.S. Group on Earth Observations document, *Improved Observations for Disaster Reduction: Near-Term Opportunity Plan* (2006). The specific activities being taken by the EHP undergo both management and scientific review of project concepts and of final project proposals when submitted for initial funding using a program council responsive to regional and topical needs. Additionally, periodic reviews are conducted on progress of multiyear projects and peer review is performed on reported project results when completed.

"The Great Southern California ShakeOut...was such a success in earthquake preparedness that it was brought back by popular demand with The Great California ShakeOut 2009, which had 6.9 million statewide participants. These efforts [were] led by the Earthquake Country Alliance in which Cal EMA and USGS participate actively as partners….When the hazardous faults of California become especially active, Cal EMA calls upon the expertise of USGS scientists...for guidance and advice. In case of a major earthquake disaster, Cal EMA relies on USGS to provide us with essential elements of information (EEI's)…

Matthew R. Bettenhausen, Secretary
California Emergency Management Agency
December 9, 2009

2009 Enacted and 2010 Program Performance

The EHP includes the following three program components: Assessment and Characterization of Earthquake Hazards, Monitoring and Reporting Earthquake Activity and Crustal Deformation, and Conducting Research into Earthquake Causes and Effects. The program's strategic plan also identifies a fourth component—Earthquake Safety Policy—that features activities embedded in each of the other program components and reflects the overall NEHRP mission to translate improvements in understanding into loss-reduction results. At the 2010 funding level, program accomplishments will include the following:

Assessment and Characterization of Earthquake Hazards

The USGS contributes to earthquake hazard mitigation strategies by: (1) developing seismic hazard maps that describe the likelihood of and potential effects of earthquakes throughout the Nation, especially in high-risk urban areas, and (2) making this knowledge available to others so that it can be used to reduce the impact of potentially damaging earthquakes. Federal, State, and local government agencies, architects and engineers, insurance companies and other private businesses, land-use planners, emergency response officials, and the general public rely on the USGS for earthquake hazard information to refine building codes, develop land-use strategies, safeguard lifelines and critical facilities, develop emergency response plans, and take other precautionary actions to reduce losses from future earthquakes.

Earthquake Drill - Pierce County, Washington,

In October, 2009, Pierce County Emergency Management led an earthquake exercise for a magnitude 7.0 earthquake on the Tacoma fault. The Hazard Mitigation Program of Washington Emergency Management Division (EMD), Pierce County Emergency Management Department, the University of Washington (UW) and the USGS participated in the development and implementation of the earthquake exercise. The USGS supplied data used to develop the various damage reports and exercise activities, and held training sessions on the geological and seismological aspects of the Tacoma fault. UW staff developed scenario ShakeMaps for the main shock and two aftershocks, and fed these into the exercise in "real-time," and the USGS built a mock "Did You Feel It?" website. Pierce County has agreed to work with the USGS Seattle office on making USGS real-time earthquake products more useful for the needs of an emergency operations center, and EMD will use ground motion models, developed by the USGS, as the basis for state and local planning.

The USGS national seismic hazard maps are used to develop new, unified model building codes for the United States. These digital maps integrate a wide range of geological and geophysical information to provide estimates of the maximum severity of ground shaking that a given location is expected to experience during the next 50, 100, and 250 years. Periodic review and updating of the seismic hazard maps to incorporate new information are among the highest priorities for the EHP. The USGS works closely with earthquake researchers, engineers, and State and local government representatives across the Nation to ensure that the maps represent the most current and accurate information available.

The scale of the national seismic hazard maps precludes taking into account local variations in the size and duration of seismic shaking caused by small-scale geologic structures and soil conditions. For high-to-moderate risk urban areas, the USGS is generating more detailed products that make it possible for local officials to make informed zoning and building code decisions. Modeling of ground motion is provided for engineering applications. In conjunction with release of these targeted products, the USGS conducts workshops to assure the proper transfer of knowledge and to help design effective mitigation strategies.

Example projects in assessment and characterization include:

National Seismic Hazard Maps — In 2008, the USGS released the next-generation national seismic hazard maps following an extensive review process. The new maps replace those from 2002, are under consideration for inclusion in updated NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, and for inclusion in the 2012 version of the International Building Code. These maps were developed using the best available science based on internal USGS studies as well as information available from government agencies, academic institutions, and industry. The USGS also produced a set of engineering design maps that are derived from the new hazard maps for use in construction

engineering standards for existing buildings developed by the American Society of Civil Engineers, and ultimately the International Building Code. In 2010, the USGS is producing a variety of other products derived from the seismic hazard maps, for use by engineers, city planners and other end-users. These include uniform hazard spectra for a broad range of structures, maps that portray the degree of certainty and resolution of seismic hazard estimates nationwide, and information on the earthquakes most likely to cause strong shaking at a given site of interest. In 2010 and continuing in 2011, the USGS scientists are conducting targeted research directed toward improvements in the next generation of national seismic hazard maps.

Monitoring improvements streamline Caribbean earthquake information

The USGS was able to rapidly assess and report on the size, location and likely impact of the January 12 earthquake in Haiti, thanks to improvements in seismic monitoring and analysis made since the devastating Sumatra earthquake and tsunami in 2004. Following that earlier disaster, USGS received a supplemental appropriation to deploy seismic stations in the Caribbean to improve earthquake detection and support a new NOAA tsunami warning system, and to upgrade analysis procedures and implement 24/7 staffing at the USGS National Earthquake Information Center. Those improvements enabled rapid reporting on this earthquakes as well as dozens of aftershocks. Supplemental funds also supported development of PAGER (Prompt Assessment of Global Earthquakes for Response), which provided within minutes an estimate of the number of people impacted by strong shaking, and thus a rapid “snapshot” of the scale of the disaster.

Hazard Maps for Urban Areas — During 2010, the USGS is focusing on advancing a collaborative urban seismic hazard mapping project in the high-risk St. Louis urban area, and completing and delivering another such project in the the Tri-State (Evansville) area of Indiana, Kentucky, and Illinois. In both these efforts, the USGS serves primarily as a coordinator, with most of the technical work being done by local partners. Partners in the St. Louis project include the University of Missouri at Rolla, Missouri Department of Natural Resources, and the Missouri State Geological Survey. Those for the Tri-State (Evansville) project include the State geological surveys of Indiana, Kentucky, and Illinois, the Southwest Indiana Disaster Resistant Community Corporation, Association of Central United States Earthquake Consortium (CUSEC), State Geological Surveys, and Purdue University.

Monitoring and Reporting Earthquake Activity and Crustal Deformation

The ANSS effort is focused on expanding and improving the performance and integration of national, regional, and urban seismic monitoring networks in the United States. The system consists of a national ANSS Backbone network, the National Earthquake Information Center (NEIC), 15 partner-operated regional networks in areas of moderate-to-high seismic activity, and the National Engineering Strong Motion Project for monitoring earthquake shaking in structures.

ANSS-Directed Funding within EHP

FY	Amount ($M)
2000	$1.6
2001	$3.6
2002	$3.9
2003	$3.9
2004	$4.4
2005	$8.9
2006	$8.0
2007	$8.0
2008	$8.8
2009	$8.8 SIR ($19.0 ARRA)
2010	$8.3
2011	$9.1

The NEIC provides information on potentially damaging earthquakes to the National Command Center; the White House; the Departments of Defense, Homeland Security (including FEMA), Transportation, Energy, and Interior; State offices for disaster services; numerous public and private infrastructure management centers (e.g., railroads and pipelines); the news media, and the public. Rapid earthquake notifications are delivered by e-mail and text message to over 140,000 users, and a suite of earthquake information products such as *ShakeMaps*, *Did You Feel It?* maps, and technical data

are available on the program's Web site, which receives more than two million hits every day. The USGS also provides near-real-time data to the National Oceanic and Atmospheric Administration (NOAA) tsunami warning centers, supporting tsunami monitoring in the Pacific Rim and disaster alerting in Alaska, Hawaii, Washington, California, and U.S. territories in the western Pacific.

Early ANSS implementation efforts (2000–2003) focused primarily on the installation of new urban recording stations in five high-risk metropolitan areas: Los Angeles, CA; Salt Lake City, UT; San Francisco, CA; Seattle, WA; and Anchorage, AK. Increased seismic monitoring capability in urban regions has two major benefits: (1) it provides rapid assessments of the distribution and severity of strong ground shaking just after an earthquake–information conveyed graphically via ShakeMap, which provides situational awareness for emergency response officials to help determine the scope and scale of the crisis they face, and (2) it provides detailed and accurate data on the shaking of the ground and structures during a damaging earthquake. These data can be used by the structural engineering community in the recovery and rebuilding phase for more earthquake-resistant design and construction in the future.

USGS Response to Magnitude 8.0 American Samoa Earthquake and Tsunami

On September 29, 2009 a magnitude 8 earthquake stuck approximately 120 miles west of the islands of Samoa, American Samoa and Tonga. The earthquake unleashed a devastating tsunami that inundated the coast. The USGS seismic station in Samoa recorded the mainshock, providing a rare record of the ground motion from this type of fault. The USGS sent two teams to the affected area. One team participated in tsunami inundation mapping and a second team deployed seismometers to capture ground motions from ensuing aftershocks, data critically needed to study seismic energy. USGS scientists will retrieve the instruments in American Samoa early in 2010 and analyze the data. Ground motion information will be incorporated into seismic hazard maps for Guam and American Samoa, which will form the basis for building codes, earthquake response planning, and hazard mitigation efforts in the region.

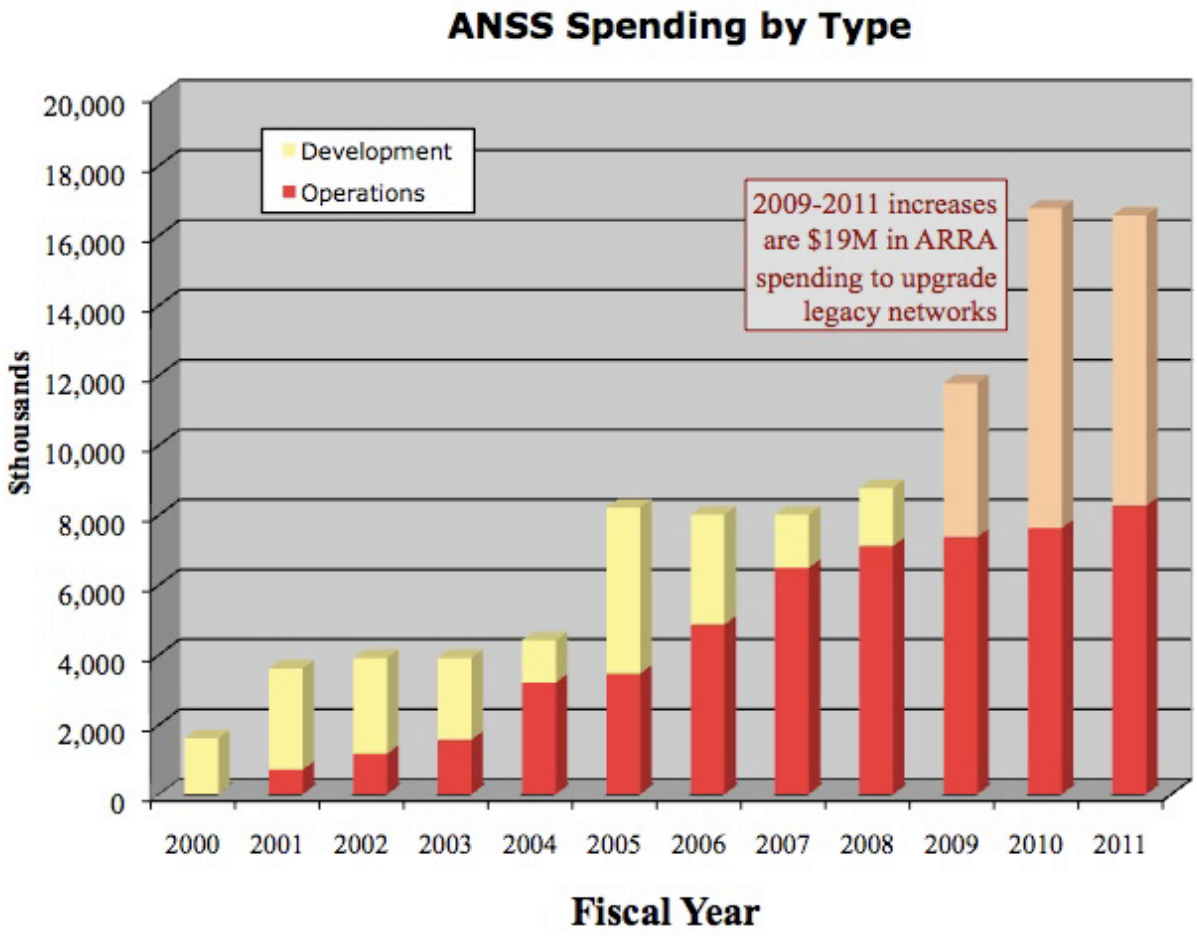
Developments in 2004–2006 included the completion of the national ANSS Backbone seismic network in the contiguous U.S., thanks to a partner contribution by the NSF. The ANSS network is now capable of detecting almost all felt earthquakes in the United States except remote areas of Alaska. The NEIC began 24x7 operations in 2006, and now typically reports on domestic earthquakes within minutes of their occurrence. By the end of 2009, the USGS and partners had installed a cumulative total of 886 ANSS earthquake monitoring stations.

A substantial increase in the number of ANSS stations, and in data processing and product generation capabilities, will be realized in 2010 and 2011 as a result of economic stimulus funding. The USGS has allocated $19.0 million of the $140 million dollars allocated to it under the ARRA to the modernization component of ANSS. Outdated equipment at hundreds of legacy seismic stations is being replaced with modern digital equipment. ARRA funding has been allocated to 13 cooperating partners, which will perform the station and network upgrades. In addition to station modernization, ARRA funds are being used to upgrade communications and processing software, and also to complete some critical software development tasks. Other ARRA funds are being used to upgrade geodetic monitoring network (see below) and the stations of the Global Seismographic Network (see that program section). In total $30.2 million in ARRA funding will be spent in 2009-2011 on improving earthquake monitoring in the U.S.

In addition, new sensor installations are underway as part of the USGS Multi-Hazards initiative. In 2010, forty new "NetQuake" sensors are being installed in the greater Seattle-Tacoma area, to collect critically needed strong ground motion from future earthquakes. Combined with the ARRA network upgrades and ARRA-funded seismic and geodetic monitoring investments being

made in 2010-2012 by the National Science Foundation, our capabilities for monitoring earthquakes in the Pacific Northwest will make a quantum improvement.

Outside of the ARRA upgrades, most resources are directed at maintaining a high level of performance of the installed system, and meeting commitments to partners for data availability, management and quality.



The chart above shows total annual ANSS-directed funding (in thousands) broken down by type. The first year of ANSS funding was in 2000; the large increase in 2005 reflects supplemental funding received as part of the tsunami initiative (most of which was added to the base in 2006). As the system has expanded through development funding, operational costs have increased. ARRA funds have permitted a renewal of system development in 2009 to 2011, mostly through targeted improvement of older seismic stations to modern ANSS quality and standards.

Example projects in monitoring and reporting earthquake activity and crustal deformation include:

Regional Earthquake Monitoring — As part of the ANSS, the USGS and cooperating universities operate regional seismic networks in areas of high seismicity. Data from all U.S. seismic networks are used to monitor active faults and ground shaking, in much greater detail

Future costs reduced through Recovery Act investments: From Alaska to Maine, hundreds of older seismic and geodetic monitoring stations will be upgraded in 2010–2011 using ARRA funds.

and accuracy than is possible with the national-scale network. Each region has appropriate local data processing capabilities; regional data are contributed to a national ANSS catalog of earthquakes. ANSS regional networks serve as State or local distribution points for information about earthquakes to the public, local and State agencies, and other regional interests. The regional data centers also relay earthquake data in real time to the USGS NEIC, as well as to other regional networks. They also provide information about regional earthquake hazards, risks, and accepted mitigation practices, and those centers located at universities provide training and research facilities for students. To support partner activities in regional earthquake monitoring, approximately $6.4 million will be provided in 2010 through cooperative agreements, $3.4 million of which comes from base program funds of which $3.0 million comes from funds targeted for development and maintenance of the ANSS. In 2009 and 2010, the USGS supports 15 regional seismic networks, structural arrays and geotechnical arrays, operated by the following colleges and universities:

Seismic Monitoring Networks Supported by the USGS	
Boston College, Weston Geophysical Observatory	University of California San Diego
California Institute of Technology	Kentucky Geological Survey
Columbia University, Lamont-Doherty Earth Observatory	University of Memphis
Montana Tech of the University of Montana	University of Oregon
Saint Louis University	University of South Carolina
University Nevada Reno	University of Utah
University of Alaska Fairbanks	University of Washington
University of California Berkeley	

In 2010, funding for regional network operations will remain a high priority, and will be directed toward ensuring robust regional network operations and maintenance.

Earthquake Early Warning — The probability of a magnitude 6.7 or larger earthquake in California in the next 30 years is greater than 99 percent. More than 25 million people are at risk from future major earthquakes along the major faults there. The USGS is working with the consortium universities that operate the ANSS California Integrated Seismic Network (CISN) to build a prototype statewide earthquake alerting system. The goal of the system is to provide public earthquake alerting --that is, automated warnings delivered before strong ground shaking arrives. The system will also provide products supporting emergency response, and will support seismological and earthquake engineering research. It will also support vested stakeholders and potential users, such as the California Emergency Management Agency, California Transportation Authority, pacific Gas & Electric, and the Bay Area Rapid Transit system. A three-year algorithm testing period was completed this year, and a second phase of integration and user development has begun.

Early warning systems have been deployed in Japan, Taiwan, Mexico, and Turkey to provide up to tens of seconds warning before strong shaking begins. Such systems can be used by utilities to rebalance electricity distribution and shut off gas lines; hospitals to initiate auxiliary power systems; and for other targeted uses. In the next two years, economic “stimulus” funding from the ARRA will be used to replace many of the older, slower earthquake recording instruments throughout California, enabling the existing systems to provide much more timely earthquake alerting.

Monitoring Deformation of the Earth's Surface — Geodetic networks provide essential information about the massive, slow deformation (strain) of the land surface near faults and the forces that cause earthquakes. Geodetic monitoring stations use precise Global Positioning System (GPS) techniques to measure changes in the shape of the Earth's surface that help reveal how strain accumulates on earthquake faults, and how those faults are slipping at depth. Precise geodetic data provides new constraints on the likely rate of large earthquakes in a region.

The USGS is working with universities, local agencies, and the Plate Boundary Observatory component of the NSF's EarthScope program to conduct geodetic investigations using GPS, LiDAR, Interferometric Synthetic Aperture Radar (InSAR), creepmeters, and sensitive long-baseline and borehole strainmeters. To address the problem of hazards in the urban Los Angeles region, the USGS operates approximately 100 stations along the San Andreas fault and in the densely-populated urban area, and processes data from state-of-the-art, continuously operating GPS stations operated by the Scripps Institution of Oceanography and the Plate Boundary Observatory (PBO). In addition, the USGS works with partner to use LiDAR and InSAR to quickly and accurately produce large aerial maps of pre- and post-earthquake land deformation.

High-resolution LiDAR data continues to be key to identifying active faults in Oregon and Washington that have the potential to generate damaging earthquakes. The USGS is using funds from the multi-hazards initiative to collect and analyze LiDAR data in four at-risk areas in Oregon and Washington. In the Portland area, LiDAR studies have identified sites for field studies aimed at clarifying whether the Gales Creek fault has slipped in the recent geologic past and thus remains a hazard. Near Mount Hood, LiDAR reveals a set of faults, each with about two meters of surface displacement, that may be part of the southern extension of the Saint Helens seismic zone; geologists from USGS and the Oregon Department of Geology and Mineral Industries (DOGAMI) will conduct trenching studies of the faults in summer of 2010. In eastern Washington, LiDAR studies have identified a major north-south fault that is approximately perpendicular to faults previously mapped in the Yakima fold and thrust belt in the Columbia Plateau; this newly found fault will be trenched during the spring of 2010. Finally, LiDAR is being used to analyze the potential interaction of faults in the Cascade Range and the Yakima fold and thrust belt in Central Washington where a massive landslide occurred on October 14, 2009.

Funds provided to support geodetic monitoring by the ARRA will benefit the USGS and its cooperators by making possible much-needed upgrades of obsolete GPS and strainmeter equipment, telemetry upgrades, acquisition of new high-precision LiDAR data, and software development. Equipment and telemetry upgrades at GPS stations will improve our capacity to receive and process data in real-time.

Geodetic Monitoring Networks Supported by the USGS	
Central Washington University	University of Colorado Boulder
San Francisco State University	University of Memphis
University of California at Berkeley	University of Utah
University of California at San Diego	University of Nevada Reno

Conducting Research into Earthquake Causes and Effects

The USGS conducts research on the causes, characteristics, and effects of earthquakes. This research has direct application in increasing the accuracy and precision of the agency's earthquake hazards assessments, earthquake forecasts, and earthquake mitigation practices.

A major focus of the USGS earthquake research is to understand earthquake occurrence in space and time. Ongoing USGS investigations reveal the physical conditions under which earthquakes initiate and grow; the processes of earthquake triggering; how individual faults in the same region interact; why some faults slip slowly without generating earthquakes while others generate earthquakes; and the factors that control variations in recurrence intervals of earthquakes along the same fault. The USGS research efforts are also directed at improving the understanding of earthquake-induced strong ground shaking and its effects. Specifically, USGS researchers are investigating how complexities in the earthquake source, Earth's crust, and near-surface soils and deposits influence seismic wave propagation and strong ground motion. Improving current techniques for forecasting the effects of strong ground motion will greatly improve seismic hazard maps for urban regions. These efforts are thus critical for cost-effective earthquake hazard mitigation. Another research priority is the identification and understanding of behavior of weak soils that liquefy and fail when subjected to earthquake shaking. Research on ground failure, carried out in collaboration with structural and geotechnical engineers, will lead to improved design of earthquake-resistant infrastructure and lifelines, such as bridges and airports, commonly built on fill or weak soil. These research activities are the principal contributor to the program's output measure for number of systematic analyses and investigations delivered to customers.

Supporting External Research Partnerships — External collaboration advances targeted research and addresses specific needs of the USGS using the experience and knowledge of world experts. The EHP provides competitive, peer-reviewed, external research support through cooperative agreements and grants that enlist the talents and expertise of the academic community, State government, and the private sector. By involving the external community, the USGS program increases its geographical and institutional impact, promotes earthquake awareness across the Nation, encourages the application of new hazards assessment techniques by State and local governments and the private sector, and increases the level of technical knowledge within State and local government agencies. Investigations and activities supported though the external awards are closely coordinated with and complement the internal USGS program goals. Many of the external projects are co-funded with other agencies and sources, leveraging the effect of USGS support. Example external program activities include: (1) mapping seismic hazards in urban areas, (2) developing credible earthquake planning scenarios including loss estimates, (3) defining the prehistoric record of large earthquakes, (4) investigating the origins of earthquakes, (5) improving methods for predicting earthquake effects, and (6) developing a prototype system for earthquake early warning system (see above). The USGS also has a cooperative agreement with the Southern California Earthquake Center (SCEC), a 40-institution research consortium that the USGS funds in partnership with the NSF. To support external work in 2009, the EHP is providing competitively awarded earthquake research grants and cooperative agreements with university, State and local partners.

The following table list the institutions and agencies receiving grants and cooperative agreements in 2010.

USGS 2010 Grants for Earthquake Research and Hazards Assessments	
Association of Bay Area Governments	Boise State University
Boston College	Brigham Young University
Brown University	California Geological Survey
California Institute of Technology	California State Polytechnic University
Carnegie Mellon University	Drexel University
Earthquake Engineering Research Institute	Earthquake Insight LLC
Harvard University	Humboldt State University
Image Cat, Inc	Missouri Division of Geology and Land Survey
New Mexico Institute of Mining & Technology	Northeast States Emergency Consortium
Oregon Department of Geology and Mineral Industries	Purdue University
Rensselaer Polytechnic Institute	San Diego State University
Southern California Earthquake Center	Stanford University
Swiss Seismology Service	Tufts University
University of Alaska Fairbanks	University of California Berkeley
University of California Davis	University of California Irvine
University of California at Los Angeles	University of California at Riverside
University of California San Diego	University of California at Santa Barbara
University of Colorado Boulder	University of Durham
University of Memphis	University of Miami
University of Nevada at Reno	University of Oregon
University of Puerto Rico Mayaquez	University of Southern California
University of Washington	University of Wisconsin Madison
University of Wyoming	URS Group, Inc.
Utah Geological Survey	Utah State University
Virginia Polytechnic and State University	Washington Department of Natural Resources
Western States Seismic Policy Council	Woods Hole Oceanographic Institute

Program Performance Overview

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
# of areas for which detailed hazard assessments are completed **(SP) (EHP)**	C	3	4	4	4	4	5	5	0	6
# of metropolitan regions where Shakemap is incorporated into emergency procedures **(SP) (EHP)**	A	5	5	5	5	5	5	5	0	5
% completion of optimal monitoring for moderate to high hazard areas* **(EHP)**	C	10.3%	11.2%	11.5%	11.7%	12.7%	18.5%	24.2%	+5.7	24.3%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (2/2)	100% (152/152)	100% (132/132)	100% (140/140)	100% (146/146)	100% (157/157)	100% (159/159)	0	100% (159/159)
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (EHP)**	A	2	152	132	140	146	157	159	+2	159
Actual cost per analysis(whole dollars)	**A**	**UNK**	**182,000**	**182,000**	**182,000**	**182,000**	**182,000**	**182,000**	**0**	**182,000**
Total projected cost ($000)	**A**	**UNK**	**27,664**	**24,024**	**25,480**	**26,572**	**28,574**	**28,938**	**+364**	**28,938**
Cumulative number of ANSS seismic monitoring stations* **(EHP) (ARRA)**	C	723	786	805	822	886	1,292	1,692	+400	1,700
# of stations operated* **(EHP)**	C	2,722	2,731	2,767	2,836	2,848	2,900	3,038	+138	3,050
Comment	*the strong performance that is projected for earthquake monitoring measures in 2010 and 2011 is due to ARRA funding for seismic network upgrades (+766 stations), plus multi-hazard funding for additional stations in the Pacific Northwest in 2011 (+50 stations).									

Activity: Geologic Hazards, Resources, and Processes

Subactivity: **Geologic Hazard Assessments**
Program Component: **Volcano Hazards**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2009 (+/-)
Volcano Hazards Program ($000)	23,901	29,445	24,421	-458	+1,250	25,213	792
Total FTE	*143*	*0*	*143*	*-1*	*+2*	*144*	*+1*

1) $333 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Volcano Hazards Program

Request Component	($000)	FTE
• Increasing Resilience to Natural Hazards	+ 1,500	+ 2
• Cooperative Partnership with University of Hawaii- Manoa and HVO	-250	0
TOTAL Program Changes	**+ 1,250**	**+ 2**

Justification of 2011 Program Changes

The 2011 budget request for the Volcano Hazards Program (VHP) is $25,213,000 and 144 FTE, a program change of +$1,250,000 and +2 FTE from the 2010 Enacted level.

Increasing Resilience to Natural Hazards **(+$1,500,000 / 2 FTE)**

This program change represents the volcano hazards component of a multihazards initiative, which would build upon the success of the MHDP in Southern California, extending the multihazards approach to at-risk areas of the Pacific Northwest and Alaska coastal communities. The USGS hazard programs are heavily integrated into regional hazard planning and mitigation activities to address multiple hazards in both Oregon and Washington. This initiative proposes improving risk assessments and monitoring capabilities in the Pacific Northwest to help decision makers and citizens prepare for and respond to natural hazards, building more resilience in that region. Expanding the multi-hazards demonstration project approach to Alaska would improve the ability of the USGS to support emergency planning and risk assessment of potential future hazards at and near the coastal population centers and would invest in earthquake, tsunami, and volcano science to support community planning in Alaska. Funds would also be used to provide the necessary data transmission improvements for the NEIC in Golden, Colorado to import real-time seismic data from the five USGS volcano

observatories. The USGS provides 24/7 detection and rapid location, analysis and dissemination of information for earthquakes world-wide. This effort would add a volcanic earthquake detection role to NEIC, providing a 24/7 backup alerting capability for USGS volcano observatories. Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases beginning on page E-1.

Cooperative partnership between the University of Hawaii-Manoa and the USGS Hawaii Volcano Observatory (-$250,000 / 0 FTE)

The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of available resources. The funding increase is being used to support a cooperative partnership between the University of Hawaii-Manoa (UHM) and the USGS HVO, formalizing and strengthening a collaborative relationship that has been established between the two entities for monitoring, hazards assessments and other research in an area of almost continuous volcanic eruption. Areas of mutual interest are identified in a Memorandum of Understanding signed by UHM and USGS in 2009.

Program Overview

Under the Stafford Act (P.L. 93–288), the Department of the Interior (Interior) has the responsibility to issue timely warnings of potential geologic disasters to the affected populace and civil authorities. Much of the data are available to the public in near real time on the program websites.

To reduce societal exposure to the threats posed by volcanoes, the VHP conducts a range of ongoing activities that may be broadly divided into volcano-hazard-assessment and volcano-monitoring components. Process-oriented research is conducted under both components to improve accuracy of hazard assessments and accuracy of interpretations and forecasts of volcanic activity. Both components provide training and technical assistance to inform decision-makers at Federal, State, and local levels on managing risks from natural hazards.

The long-term goal for the volcano-hazard-assessment component of VHP is to provide hazard assessments for all dangerous volcanoes in the U.S. and its territories and to establish response plans for all communities that they threaten. Each volcano hazard assessment requires a geologic map and involves field work, laboratory analysis, and data analysis by research scientists, typically requiring three to five years to complete.

An Overview:
Volcano Hazards Program (VHP)

- Provides the geoscience data and information, analyses, and research needed to reduce the loss of life, property, and economic and societal impacts of hazards related to volcanoes.
- Accomplishes the VHP mission through a system of five observatories that continuously monitor seismic activity, surface deformation, gas emission, and satellite imagery of high-threat volcanoes.
- Interprets real and near-real time data based on detailed geologic field investigations and hazard assessments. Eruption warnings and volcano-status notifications are rapidly disseminated to the public and private sectors and impacted communities and businesses through a system of telephone call-downs and electronic notification.

The volcano-monitoring component of VHP involves collection and scientific interpretation of real-time and near-real-time geophysical data indicative of the state of volcanic systems; integration of data collected by other groups, such as National Aeronautics and Space

Administration (NASA) and NOAA satellite imagery; management and distribution of data to provide hazard awareness, transparency of operations, and credibility of interpretations with the public and to inform decision-makers on managing risk from volcanic hazards; and technical assistance to decision-makers on managing risk from natural hazards.

VHP's volcano monitoring network is maintained and operated through five volcano observatories: Alaska Volcano Observatory (AVO), Cascades Volcano Observatory (CVO), HVO, Long Valley Observatory (LVO), and Yellowstone Volcano Observatory (YVO). AVO also manages volcano monitoring in the Commonwealth of Northern Mariana Islands. These observatories are operated in partnership with the Universities of Alaska, Washington, Utah, and Hawaii, the Alaska Division of Geological and Geophysical Surveys, and Yellowstone National Park. Collaborations with NOAA, Federal Aviation Administration (FAA), the Air Force Weather Agency (AFWA), and the International Civil Aviation Organization (ICAO) provide early warning and situational awareness of volcanic ash threats to jet aircraft. Through a partnership with U.S. Agency for International Development (USAID), VHP's Volcano Disaster Assistance Program (VDAP) provides emergency response support, infrastructure-building, and training to developing nations faced with volcanic disasters. The VDAP has saved thousands of lives. The VHP also supports the Smithsonian Institution Global Volcanism Program to collect and disseminate information about volcanic activity worldwide and to conduct research about volcanic hazard potential and impacts using the Smithsonian's global volcanism database.

The VHP has made progress on both monitoring and hazard-assessment efforts and in underlying research. Using funds provided by the FAA during 1996 through 2008, the volcano monitoring network was expanded to include 31 remote volcanoes in Alaska that threaten international air routes. By late 2009, 52 volcanoes were monitored in real time by the VHP with multiple geophysical ground stations. Generally, one to two hazard assessments have been published each year, and there has been steady progress on development of community response plans in Washington and Oregon. Synthesis of the many data streams gathered from erupting volcanoes together with laboratory and numerical simulations have led to a more realistic understanding of the source magma systems and surface volcanic impacts, as documented in 60 to 100 peer-reviewed publications per year. Each eruption and period of unrest provides the basis for improving the monitoring and interpretation of the next event.

The implementation of the NVEWS is now a major goal of the VHP, following a systematic assessment of volcanic threat and monitoring capabilities for all 169 of the Nation's active volcanoes (USGS Open-File Report 2005-1164; *http://pubs.usgs.gov/of/2005/1164/*). The assessment concludes that many U.S. volcanoes are under-monitored. As part of the NVEWS plan, a comprehensive inventory of current monitoring instrumentation and prescriptions of equipment suites constituting appropriate monitoring levels was published in 2008 (USGS Scientific Investigations Report 2008-5114; *http://pubs.usgs.gov/sir/2008/5114/*). An implementation plan for the NVEWS path forward will be completed in 2010. NVEWS will move the VHP towards state-of-the-art monitoring of all hazardous volcanoes at levels commensurate with the threats posed. The NVEWS concept is also designed to provide 24 x 7 situational awareness, organized and openly accessible data for all potentially hazardous U.S. volcanoes; new hazard information products for the most vulnerable communities, businesses, and infrastructure; and advances in research on volcanic processes, technology development, and hazard evaluation and risk mitigation. The priority targets for instrumentation are 21 volcanoes in Alaska, Washington, Oregon, California, Hawaii, and CNMI that have inadequate instrumentation, and 20 volcanoes in Alaska and CNMI that pose a hazard to aviation but have no ground-based monitoring now.

An external review of the VHP was conducted by the AAAS in 2007, using a panel of six outside experts. The AAAS panel determined that the VHP had successfully executed its previous 5-Year Plan and previous (2000) external review recommendations, and that the current 5-Year Plan was sound. The panel endorsed the NVEWS plan, and proposed that the VHP work more closely with State and local partners in developing risk-focused products that deal with future eruption scenarios and community vulnerability. The VHP is acting on these recommendations. A number of new or strengthened academic and state agency partnerships were implemented in 2009.

2010 Enacted and 2011 Program Performance

At the 2011 funding level, VHP accomplishments will include the following:

Response to Eruption and Unrest — The VHP will direct resources towards response to volcanoes that are erupting or exhibiting unrest (earthquakes, deformation, increased heat emission, or gas emissions) that may be precursory to an eruption. Although it is impossible to predict which volcanoes will erupt or show unrest in 2011, the new vent at the summit of Kilauea volcano in Hawaiian Volcanoes National Park will likely continue to require close attention. Explosions and high levels of toxic gas emission pose a serious danger to national park visitors and nearby residential areas, requiring close coordination among HVO, the National Park Service (NPS), and Hawaii County Civil Defense, through an Incident Command structure established by NPS. Explosive eruptions are also likely in Alaska. Such events may require program-wide responses lasting from days to months. Recurrent episodes of unrest in Long Valley (Mammoth Lakes, California) and Yellowstone (Wyoming) calderas carry the potential for significant economic disruptions in these popular recreational destinations that can only be mitigated by the real-time monitoring data and the credibility and transparency in development of warnings and advisories that VHP provides.

The latter situation was illustrated by an intense volcano-tectonic seismic swarm that occurred in Yellowstone during ten days spanning New Year's Day 2009. There were two levels of VHP's involvement through its YVO. The first was advising the NPS-led Incident Command on the characteristics of the activity and likely scenarios. Despite the disturbing nature of continuous shaking, the YVO was able to show that the swarm was not building towards an eruption. The event attracted nation-wide attention. The VHP devoted considerable resources to explaining how the Yellowstone volcanic and hydrothermal system works and that most unrest here does not lead to catastrophe.

Beginning in late March and continuing through April 2009, 19 explosions from Mt. Redoubt lofted ash to flight levels and two large lahars swept down the Drift River Valley, surrounding and partially inundating the Drift River Oil Terminal (DROT). The AVO forecasted the eruption (although the start was later than anticipated), provided an accurate scenario for how it would progress, and tracked the activity 24/7 through its entire course. The primary impacts were disruption of air travel and international air cargo operations, the temporary cessation of oil transfer operations at DROT - requiring in turn the cessation of oil production - and light ash falls on nearby communities, including Anchorage. Job losses were associated with uncertainty of air cargo operations in the Anchorage area owing to volcanic ash affecting flight operations. The AVO, with support from the other observatories and staff at Menlo Park and in partnership with federal and state agencies in Anchorage, helped to minimize disruption of air traffic and maximize safety of workers at DROT.

Late in calendar 2009 (early 2010), a major joint project with NASA was completed: development of a prototype “smart spider” network. The “spiders” are three-legged stand-alone, multi-instrument monitoring stations that can be landed by helicopter on almost any terrain without putting personnel at risk on the ground. The stations then develop their own telemetry network and change it in response to damage to any of the units. This system makes possible rapid deployment of a monitoring network on suddenly restless volcanoes with minimum risk to personnel, and will likely find application worldwide.

The VDAP, a joint project with USAID/ Office of Foreign Disaster Assistance, continued to work in 2010 with Indonesian counterparts on building monitoring infrastructure and crisis response capacity on North Sulawesi, an effort supported by Department of State (DOS) and lauded at high levels of the Indonesian government. VDAP also continued its life-saving efforts during the eruption of Huila Volcano, Colombia, and provided critical advice to the governments of Saudi Arabia and Tanzania concerning volcanic hazards in those countries. All of VDAP’s foreign responses follow requests from foreign governments that are evaluated by DOS and/or USAID in terms of US foreign policy interests.

> “We rely on [USGS VDAP’s] judgment and expertise to inform local partners on management of volcanic hazards……Their responses not only benefit local inhabitants but also foreign policy interests of the U.S. Government.”
>
> Peter Morris
> Technical Assistance Grp Leader
> USAID OFDA, Nov 2009
>
> November 2009

In 2011, VDAP will extend its monitoring infrastructure and technology transfer activities to the island of Java, Indonesia and expand its global rapid-response capability, for which it remains as the foremost emergency volcano team in the world.

Progress was also made in 2009 and 2010 and will continue in 2011 in moving ash fall models from research tools to operational use.

Monitoring and Operations Improvements funded by ARRA — A total of $15.2 million in ARRA funds was applied to instrument purchases, contracts for services, and cooperative agreements to accomplish these improvements. Of this, $6.9` million was awarded to 15 universities and state agencies. Eleven of the awardees are new partners for the VHP, providing a broad array of expertise and perspectives that will enhance the program. ARRA improvements are currently tracked by number of stations upgraded per year, number of monitoring and telemetry nodes upgraded, and percent of very high threat volcanoes with optimal level monitoring.

Volcanic Hazard Assessments and Systematic Analyses — The VHP will continue to make progress on production of volcanic hazard assessments to guide development of community response plans and interpretation of volcanic unrest. Increasingly, this work will include quantification of risk through consideration of vulnerabilities. The VHP will also continue to publish the results of high-quality research on volcanic processes for which it is justly acclaimed, with the goal of 75 systematic analyses (including reports, maps and hazard assessments) delivered to the public in 2011. An important, peer-reviewed volume on the 2004-2008 lava dome-building eruption episode of Mount St. Helens was published in 2009, bringing the annual total of systematic analyses to 99, and a comparable compendium of work on the 2006 explosive eruption of Augustine Volcano, Alaska, will be completed in 2010. These publications will document lessons learned for application in future volcanic crises.

Eruption Response Plans — An interagency community response plan for the Mount St. Helens – Mount Adams region of Washington State was completed in 2009. A national volcanic-ash operations plan for aviation involving the FAA, USGS, NOAA, and AFWA was completed in 2007. This plan, which mirrors the operational procedures of the ICAO global ash avoidance program, is in support of the U.S. interagency program to detect, track, and warn about volcanic-ash clouds that affect the safety of flight operations in the National Airspace. An interagency operating plan for volcanic ash was also developed for Alaska in 2008. The development of a regional ash-aviation plan for the western conterminous United States, which was started in 2009, will be completed in 2010.

Program Improvements — ARRA funding is making possible a major leap in the level of monitoring of the Nation's hazardous volcanoes, and also in VHP's ability to accurately interpret and communicate monitoring information. The ARRA has also substantially broadened the partnerships that help VHP accomplish its mission. In 2010, the VHP will complete an implementation plan for NVEWS, a blueprint for improved monitoring and enhanced information dissemination for the future. Implementation will move forward as funding permits. A first priority is the development of inter-operability among the observatories, allowing all to directly aid in the response to a crisis affecting one.

USGS 2009 Cooperative Agreements for Volcano Monitoring and Research	
University of Alaska Fairbanks	Alaska Division of Geological and Geophysical Surveys
University of Utah	Yellowstone National Park
University of Oregon	Smithsonian Institution
University of Hawaii Hilo	USAID/Office of Disaster Assistance
University of Washington	Air Force Weather Agency

USGS 2009 ARRA Cooperative Agreements for Volcano Monitoring and Research (2010-2011)	
University of Alabama	Alaska Division of Geological And Geophysical
Boise State University	University of Utah
California State University Fullerton	Wyoming State Geological Survey
University of Alaska Fairbanks	Washington State Division of Natural Resources
University of Wisconsin	Oregon Division of Geology and Mineral Industries
University of South Florida	University of Hawaii Manoa
University of Washington	Southern Methodist University
Northern Arizona State University	

Program Performance Overview

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
# of areas for which detailed hazard assessments are completed **(SP) (VHP)**	C	45	46	47	48	47	48	49	+1	49
% of moderate to very high threat volcanoes with published hazard assessments (denominator reset to 101) **(SP) (VHP)**	C	UNK	UNK	UNK	47.5% (48/101)	46.5%	47.5% (48/101)	48.5% (49/101)	+1%	48.5% (49/101)
# of monitoring and telemetry nodes upgraded (e.g., analog to digital conversion, added sensors, improved power systems, upgraded radio transmitters and receivers) **(VHP) (ARRA)**	A	UNK	UNK	12	13	15	46 (Approximate reflects ARRA)	95 (Approximate reflects ARRA)	+49	0
% of very high threat volcanoes with optimal level monitoring (X number of 18) **(VHP) (ARRA)**	C	UNK	UNK	22.2%	22.2%	22.2%	22.2%	33.3% (includes ARRA Upgrades)	+11.1%	44.4%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (1/1)	100% (75/75)	100% (71/71)	100% (75/75)	100% (99/99)	100% (75/75)	100% (75/75)	0	100% (75/75)
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (VHP)**	A	1	75	71	75	99	75	75	0	75

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Total projected cost ($000)		**500**	**22,500**	**21,300**	**22,500**	**29,700**	**22,500**	**22,500**	**0**	**22,500**
Actual cost per analysis (whole dollars)		**500,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**0**	**300,000**
# of monitoring stations operated by VHP	C	694	714	734	737	743	743	758	+15	775
# of stations upgraded with ARRA funds per year **(VHP)**	A	UNK	UNK	UNK	15	2	46	95	+49	NA
Total # of stations operated and/or upgraded by **VHP**	A	UNK	UNK	UNK	752	745	789	853	+64	NA
% of moderate to very high threat volcanoes with at least basic real time monitoring **(VHP)**	C	UNK	UNK	UNK	37.6% (38/101)	37.6% (38/101)	37.6% (38/101)	39.6% (40/101)	+2%	40.6% (41/101)

Activity: Geologic Hazards, Resources and Processes

Subactivity: **Geologic Hazard Assessments**
Program Component: **Landslide Hazards**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1,2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Landslides Hazards Program ($000)	3,350	15,210	3,405	-80	0	3,325	-80
Total FTE	*22*	*0*	*22*	*0*	*0*	*22*	*0*

1) $41 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes

The 2011 budget request for the Landslides Hazards Program (LHP) is $3,325,000 and 22 FTE. There are no program changes proposed in Landslide Hazards in 2011.

Program Overview

Landslide hazard research concentrates on understanding landslide processes, developing and deploying instruments that monitor threatening landslides, and forecasting the onset of catastrophic movement of future landslides. Research into processes and forecasting methodologies is conducted on the types of landslides that produce losses in the United States such as landslides related to steep slopes, heavy rains, and vegetation loss due to wildfires.

The USGS deploys near-real-time monitoring systems at sites near Yosemite National Park in California, Seattle, Washington, and in Portland and near Newport, Oregon. These sites provide continuous rainfall and soil-moisture and pore-pressure data needed to understand the mechanisms of landslide occurrence. Such understanding can form the scientific underpinnings for early warning of

An Overview:
Landslides Hazards Program

- Gathers information, conducts research, responds to landslide disasters, and produces products that can be used by a broad user community, including Federal, State, and local governments and the private sector.
- Focuses investigations on research to better understand, assess, and monitor the causes and mechanisms of ground failure to reduce losses from landslides through improved understanding of landslide hazards and application of new strategies for hazard mitigation.
- Provides landslide-hazard assessments for land-use, emergency management, and loss reduction measures. Studies of landslide susceptibility and hazards provide much needed information to reduce landslide losses in parts of the country that have significant landslide problems including California, the Pacific Northwest, and the Blue Ridge of the Eastern United States.
- Cooperates with local partners in California, Colorado, Oregon, and Washington, as well as Federal agencies such as the National Park Service (NPS) and the Forest Service.

conditions that may trigger landslides. A landslide early-warning system based on such information is useful in reducing hazards in landslide-prone areas.

USGS scientists respond to landslide emergencies and disasters nationwide. Federal, State, and local agencies are assisted through landslide site evaluations and recommendations of strategies for reducing ongoing and future damages from landslides. When there is sufficient information of a particular area, such as in southern California, LHP can provide information on potential hazards. If rainfall intensity-duration thresholds for landslide activity have been developed for an area or if landslide-hazard maps have been produced, the LHP can issue an advisory. The LHP works in conjunction with the National Weather Service (NWS) to issue advisories and press releases regarding the potential for landslide activity in previously burned areas in southern California.

> The USGS participation in monitoring the Ferguson Rockslide near Yosemite National Forest has been critical in ensuring public safety on lands of the Sierra National Forest. The information collected by your scientists has been critical in our estimates of the potential for flooding of upstream areas if the Ferguson rockslide fails and dams the Merced River. Monitoring of the slide has been a model of collaboration and partnership between several government agencies including USGS, USDA Forest Service, California Departments of Transportation and Water Resources and Mariposa County.
>
> Edward C. Cole Forest Supervisor
> U.S. Department of Agriculture, Forest Service
> Sierra National Forest
>
> August 27, 2009

For foreign disasters, the USGS works with the USAID's Office of Foreign Disaster Assistance (OFDA) in responding to appeals for technical assistance from affected countries.

The USGS provides timely information through the National Landslide Information Center (NLIC). The Center communicates with the public about ongoing emergency responses and provides information to the external user-community through fact sheets, books, reports, and press releases, consistent with Interior's goal to protect lives, resources, and property by providing information to assist communities in managing risks from natural hazards. The NLIC maintains several databases: the Landslide Bibliography (more than 15,000 entries), the International Landslide Experts Roster of about 2,000 entries, and Major Landslide Events of the United States (part of the USGS National Atlas). The NLIC also has real-time measurements from ongoing landslide monitoring projects available for viewing via the Internet. These measurements are used to forecast landslide movement or changes in an individual landslide's behavior.

The USGS conducts monitoring efforts in cooperation with other Federal, State, and local agencies, including the NPS; Bureau of Land Management (BLM); Federal Highway Administration; the NWS, California, Washington, Oregon, and Colorado State Departments of Transportation; Colorado Geological Survey; Colorado School of Mines; DOGAMI, and private companies.

2010 Budget and 2011 Program Performance

The 2011 budget request for the LHP is $3,325,000 and 22 FTE, a net program change of $80,000 from the 2010 Enacted level.

The LHP includes the following three program components: Landslide-Hazard Assessment Activities, Landslide Monitoring Activities, and Landslide Information Dissemination Activities. LHP accomplishments will include the following:

Landslide-Hazard Assessment Activities:

(Estimates for 2009, $2.0 million, 2010 $2.0 million, 2011 $2.0 million)

Risk/Hazard Assessments Delivered to Customers — In 2009, the LHP delivered emergency assessments of debris-flow hazards for the eight large fires in southern California and the Basin Fire in Big Sur in northern California to the National Weather Service's Oxnard and Monterey Offices. The assessments were also provided to County Flood Control Districts and State and County Offices of Emergency Services. The Landslide debris-flow assessments for areas burned by fires in this region were able to be processed in a week's time as were the assessments of the Jesusita fire outside Santa Barbara and the Moon fire in northern California, both of which were provided to the U.S. Forest Service (USFS) Burned Area Emergency Response teams. The LHP is providing these products as part of the MHDP for southern California where it works with other USGS disciplines, other Federal agencies and State and local government agencies. The burned areas in southern California are highly susceptible to landslides during the winter rainy season, and even small amounts of rain can have disastrous consequences. In 2009, the LHP provided landslide hazard assessments for USFS for Snodgrass Mountain, Colorado which the USFS used in decisions to restrict part of the mountain for ski area development. Experts for the LHP also provided technical assistance to the NPS to evaluate its plan for reducing rock fall hazards in Yosemite National Park. In 2011, LHP will continue to work with the DOGAMI to prepare landslide hazard assessments from acquired LiDAR data that can be used by agencies in Oregon for planning and response purposes.

Southern California - Landlide Advisories

Strong rain storms that struck Southern California in January 2010 posed serious risks to life and property from debris flows in areas that had been previously burned. NOAA and the National Weather Service in cooperation with the Landslide Hazard Program, through its joint NOAA/USGS Flash-Flood and Debris Flow Early Warning System, issued flash flood/debris flow advisories to numerous neighborhoods that had been previously burned in Southern California. The advisories resulted in evacuations and protection of life and property.

Counties that have Adopted Improved Land-Use Plans, Emergency Response Plans or Other Hazard Mitigations Measures — In 2009 and 2010, the LHP will continue to provide information to counties and other jurisdictions in Oregon, California, Colorado, eastern United States, and Interior land management bureaus that incorporate this information into emergency response and land-use plans and warning systems. In 2009, the LHP provided susceptibility maps, hazard assessments, and emergency warnings to National Forests in northern and southern California, to several National Parks in California, to the California Department of Transportation and the California Coastal Commission, and to communities in Oregon, Colorado and California. All of these jurisdictions used the USGS products to mitigate the effects of landslides and debris flows through land-use planning, response planning, and warning systems.

Landslide Monitoring Activities

(Estimates for 2009, $1.0 million, 2010 $1.0 million, 2011 $1.0 million)

Models Used to Interpret Monitoring Data —In 2009 USGS scientists were recognized in the journal "Nature Geoscience," (2009, volume 2) and the New York Times for their innovative research showing that atmospheric tides induce daily movement at the Slumgullion landslide in Colorado, a huge landslide which they had been monitoring for years. In 2010, the LHP will continue to develop rainfall thresholds for areas burned in southern California that will refine the predictive capabilities of the Joint NOAA/USGS Early Warning System. In 2010, the LHP will

continue monitoring and analysis of the rainfall response of landslides and landslide-prone areas in western Oregon, at the Ferguson landslide near Yosemite National Park and along U.S. Highway 50 in California.

Landslide Hazards Emergency Response — In 2010, the LHP will continue to respond to landslide emergencies in the United States and internationally and to monitor these landslides where necessary. Information and maps of post-fire debris flows in southern California will be entered into interactive geographic information system (GIS) databases to provide immediate and comprehensive response tools for decision makers and the public. Landslide emergencies were posted through Interior's Common Alert Protocol to reach a large audience of land and emergency managers and will continue to be posted in 2010. In 2010, the LHP will provide information on debris flow probability, volume, and inundation areas from a hypothetical set of recent burned areas for the Winter Storm Scenario for a response exercise in southern California. In conjunction with the exercise, the LHP will be releasing a web-based survey instrument for the public to register landslide information after it happens in their neighborhoods. This web-site will be similar to the successful earthquake web site "Did You Feel It?".

Landslide Information Dissemination Activities
(Estimates for 2009, $0.3 million, 2010 $0.3 million, 2011 $0.3 million)

National Landslide Information Center (NLIC) — The LHP will continue to respond to inquiries from the public, educators, and public officials on hazard mitigation, preparedness and avoidance strategies for landslide hazards. The NLIC convened a session at the Geological Society of America's fall 2009 meeting in Portland, Oregon, where it facilitated States and the USGS and other Federal agencies to exchange landslide data and information. The NLIC will continue to provide leadership in 2010 for the National Landslide Hazard Exchange Group including hosting a web site.

Publications for Users of Hazard Information — In 2010, the LHP will expand the distribution of a handbook on landslide hazards for non-scientists published in 2008 by the USGS under the auspices of the International Landslide Consortium. The USGS will facilitate the translation of this handbook into Chinese, Japanese, Portuguese, and Spanish. During 2010 and 2011, LHP will complete 15 systematic analyses each year, including maps, technical reports, and peer-reviewed research papers, for technical users of landslide information and decisionmakers.

Program Performance Overview

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
# of landslide-susceptible areas covered by hazard assessments (cumulative) **(LHP)**	C	1	2	2	3	3	4	5	+1	6
Total projected cost ($000)		**UNK**	**UNK**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**0**	**1,000**
Actual cost per analysis (whole dollars)		**UNK**	**UNK**	**1,000,000**	**1,000,000**	**1,000,000**	**1,000,000**	**1,000,000**	**0**	**1,000,000**
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (1/1)	100% (16/16)	100% (15/15)	100% (15/15)	100% (15/15)	100% (15/15)	100% (15/15)	0	100% (15/15)
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (LHP)**	A	1	16	15	15	15	15	15	0	15

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Activity: Geologic Hazards, Resources and Processes

Subactivity: **Geologic Hazard Assessments**
Program Component: **Global Seismographic Network**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1,2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Global Seismographic Network ($000)	5,482	0	5,778	-138	-250	5,390	-388
Total FTE	*10*	*0*	*10*	*0*	*0*	*10*	*0*

1) $30 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for the Global Seismic Network Program

Request Component	($000)	FTE
• Unrequested Congressional Increase	-250	0
TOTAL Program Changes	**- 250**	**0**

Justification of 2011 Program Changes

The 2011 budget request for the Global Seismographic Network (GSN) program is $5,390,000 and 10 FTE, a program change of -$250,000 and 0 FTE from the 2010 Enacted level.

General Decrease for the Global Seismographic Network (-$250,000 / 0 FTE)

The reduction eliminates unrequested congressional funding and will keep the core program intact while allowing the USGS to make the best use of available resources.

Program Overview

2010 Enacted and 2011 Program Performance

The Global Seismographic Network (GSN) has become a critical element of the USGS hazard warning activities and will be operated indefinitely. With proper lifecycle maintenance and upgrades the network can produce data indefinitely and with expanded capabilities. This is now being achieved through the ARRA (see inset next page). The operation of the GSN is accomplished in cooperation with many international partners who, in most cases, provide facilities to shelter the instruments and personnel to oversee the security and operation of each station. The USGS tasks include station maintenance and upgrades, monitoring and maintaining telecom-munications, troubleshooting problems and providing major repairs,

conducting routine service visits to network stations, training station operators, providing direct financial aid in support of station operations at those sites lacking a host organization, and ensuring data quality and completeness.

As part of GSN activities, the USGS and Incorporated Research Institutions for Seismology (IRIS) evaluate, develop, and advance new technologies in sensors, instrument installation, data acquisition, and management. To improve performance, stations with unusually high background noise are relocated to quieter sites or configurations (e.g., burying sensors in boreholes) so that smaller events (earthquakes or explosions) or signals of interest may be detected.

Under a MOU between the USGS and NSF, the GSN Program is overseen by a "Standing Committee" of advisors, consisting of external stakeholders and one USGS representative. The GSN Standing Committee typically meets twice a year.

An Overview:
Global Seismic Network

- Provides high-quality seismic data to support earthquake alerting, tsunami warning, hazards assessments, national security (through nuclear test treaty monitoring), earthquake loss reduction, and research on earthquake sources and the structure and dynamics of the Earth.
- A joint program between the USGS and the NSF, implemented by the USGS, the Institute for Geophysics and Planetary Physics (IGPP) of the University of California, and the Incorporated Research Institutions for Seismology (IRIS), a consortium of universities.
- Currently consists of 150 globally-distributed stations, installed over two decades by the USGS and IGPP. The USGS is responsible for maintenance and operation, data collection, and quality control of two-thirds of the GSN stations, and IRIS supports the University of California to operate and maintain the other third.

97 percent of GSN stations transmit real-time data continuously to the USGS NEIC in Golden, Colorado, where they are used, with other data, to rapidly determine the locations, depths, magnitudes, and other parameters of earthquakes worldwide. The high quality of GSN data allows the data to be used for the rapid determination of the geometric orien-tation of the fault that caused the earthquake and provide an estimate of the length of the fault that ruptured during the earthquake.

The rapid availability of earthquake information is critical for first responders and government officials responsible for assessing an earthquake disaster. In the case of significant domestic earthquakes, the USGS and partners provide information to Federal and State emergency management and public safety agencies, operators of transportation facilities, public utilities, and national news media. In the case of potentially damaging events outside the United States, such as the earthquake in Haiti, information from the NEIC is immediately sent to the Department of State, embassies and consulates in the affected region, the USAID OFDA, the Red Cross, and the United Nations, as well as national and international news media.

GSN stations provide near-real-time data to NOAA tsunami warning centers, supporting tsunami monitoring in the Pacific Rim and disaster alerting in all U.S. coastal states and territories in the Pacific and Caribbean. NOAA relies on GSN real-time data to trigger analysis of the ocean-bottom sensors that detect tsunami waves, making it possible for NOAA to transmit

Recovery Act Investments in the GSN: The USGS has committed $4.7 million of ARRA funding for the lifecycle replacement of obsolete equipment at GSN stations worldwide. Combined with a similar-size investment in the GSN being made by the National Science Foundation, through IRIS, the entire network will be refreshed by 2015. This will allow the network's data, which is critical for hazard warning, nuclear treaty monitoring and scientific research, to continue uninterrupted into the future. Moreover, these investments will improve data quality and, because station equipment is being standardized, allow for more efficient management of the network.

tsunami alerts to response agencies within minutes of these quakes.

All GSN data are freely and openly available to anyone via the Internet. Copies of all the data from the USGS GSN stations are sent to the IRIS Data Management Center (DMC) in Seattle, Washington. Demand at the DMC for GSN data is high –for example, the DMC fulfilled over 340,000 requests for GSN data in 2008. In addition, data from most GSN stations are currently available within hours of large earthquakes to the worldwide user community via the USGS web-based *Live Internet Seismic Server*.

Data from the GSN are used extensively for basic and applied research on earthquakes, Earth structure, and other geophysical problems in studies conducted and supported by the USGS and other agencies like NSF, the U.S. Department of Energy, and the U.S. Air Force. Some of this research and data support national security through the seismic monitoring of nuclear explosions and the improved calibration of nuclear explosion monitoring networks.

The GSN continues its close cooperation with the global deformation monitoring community, with co-located GPS instrumentation at 43 GSN sites, and shared communications (telemetry) infrastructure in Africa, Siberia, and at Easter Island in the Pacific. The USGS is also evaluating the use of GSN data for near-term climate change studies. Recent research has shown that ocean storms have been increasing in frequency and intensity over several decades.

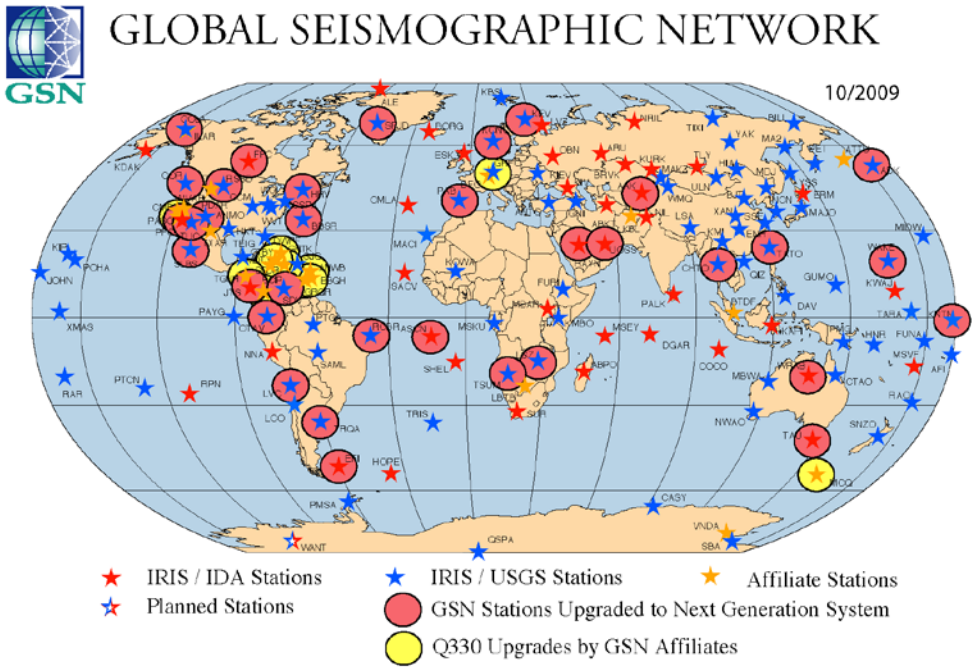
In terms of cost-performance, other federal government programs benefit by use of the GSN infrastructure (station sites and communications) by reducing their operational costs. For example, the US contributes seismic data from 34 GSN stations to the International Monitoring System for the Comprehensive Nuclear Test Ban Treaty, a United Nations organization. It would cost the U.S. at least $1.0 million per year to maintain a separate network for this purpose, and that separate network would cost the government approximately $4.0 million to develop. By leveraging the GSN investment, another purpose is achieved at no cost.

Given the high rate of significant earthquakes around the world, the GSN is an important tool in earthquake-related education and outreach. The USGS has worked with IRIS to develop educational museum displays based on data from the GSN. These displays explain the basic concepts of seismology and earthquake occurrence and have proven to be quite popular with the public. Displays are in place at the Smithsonian Institution in Washington, D.C., the American Museum of Natural History in New York, the Carnegie Museum in Pittsburgh, the USGS Headquarters, the New Mexico Museum of Natural History in Albuquerque, and the Franklin Institute's traveling "Powers of Nature" exhibit.

At the 2011 funding level, the GSN will:

- Operate the 100-station, USGS portion of the network at a high level of data recovery, real-time telemetry performance, and high cost-efficiency;
- Continue deployment of ARRA-funded station upgrades (“next-generation” data-loggers and other equipment) to improve station reliability and data quality (see map this page);
- Make progress on the development of low-maintenance seismic stations for deployment at less accessible sites; and
- Work with partners in the U.S. Air Force, the Comprehensive Nuclear Test Ban Treaty Organization, and the International Federation of Digital Seismographic Networks, to improve the efficiency of station operations and reduce maintenance costs.

In 2010, the USGS will continue to strive to maintain the GSN at high reliability and low cost. The USGS portion of the GSN has grown from 72 to 100 stations since 1998. Through the Tsunami Warning Initiative, the USGS has added GSN-affiliated stations in the Caribbean and increased the number of stations with real-time telemetry over the past four years, providing new capabilities for the network.



Map showing progress upgrading the stations of the GSN, through October, 2009. Upgrades will continue in 2010 using economic stimulus (ARRA) funds..

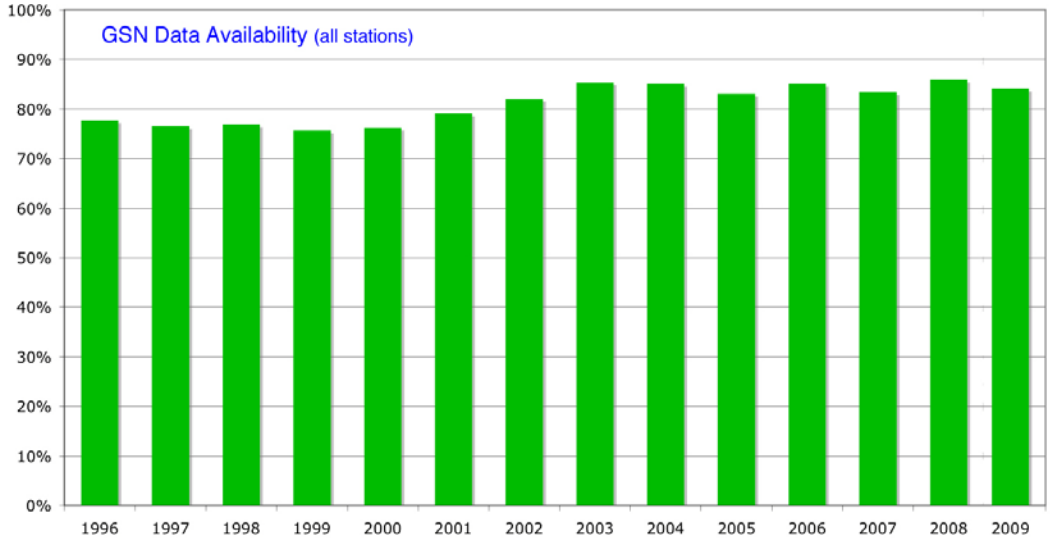


Figure 2. The chart shows the availability of GSN data, which typically exceeds 85 percent. This data return surpasses that of other global seismic monitoring opera-tions such as that run by the Comprehensive Nuclear Test Ban Treaty Organization. Data availability in 2009, through November, was just 83.5 percent, due to stations in Russia being off-line because an intergovernmental agreement had expired (those data were recovered in December, 2009). All GSN data passes though a quality control process before archiving, and GSN archives are heavily used by researchers.

Program Performance Overview

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Provide information to assist communities in managing risks from natural hazards**										
# of GSN next-generation systems deployed (of 87 needed) **(GSN) (ARRA)**	C	0	0	9	22	22	40	54	14	87
Efficiency and Other Output Measures										
# of stations operated **(GSN)**	C	90	95	99	100	100	100	100	0	100
% data availability for real-time data from the GSN **(GSN)**	A	88%	87.8%	87%	84%	83.5%	88%	87%	-1%	90%

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Activity: Geologic Hazards, Resources, and Processes

Subactivity: **Geologic Hazard Assessments**
Program Component: **Geomagnetism**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1,2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Geomagnetism ($000)	2,092	0	2,138	-37	0	2,101	-37
*Total FTE**	*17*	*0*	*16*	*0*	*0*	*16*	*0*

1) $38 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes

The 2011 budget request for the Geomagnetism program is $2,101,000 and 16 FTE. There are no program changes proposed in Geomagnetism in 2011.

Program Overview

The program consists of three main elements:

- Geomagnetic observatory operations;
- Data transportation, management; processing and dissemination, and
- Scientific research, to develop space weather diagnostics for hazard mitigation.

Short-term variations in the Earth's magnetic field, in particular those during geomagnetic storms, are hazardous to satellites and electrical power distribution systems and make radio communications, navigation, and geophysical surveys difficult. During large magnetic storms, astronauts and high-flying aircraft pilots can be exposed to dangerous levels of radiation. Data from the program's observatories are used for tracking near-Earth space-weather conditions by both the NOAA Space Weather Prediction Center (SWPC) and the Air Force Weather Agency (AFWA). With those and other partners, the program is an integral part of the interagency National Space Weather Program.

Overview:
The Geomagnetism Program

- Monitors the Earth's magnetic field through an array of ground-based magnetic observatories
- Provides high temporal resolution records of magnetic field variations covering long timescales
- Disseminates magnetic data to various governmental, academic, and private institutions to conduct research into the nature of geomagnetic variations for purposes of scientific understanding and hazard mitigation.

The estimated annual economic impact of magnetic storms runs into the hundreds of millions of dollars, not to mention the potential impact upon national security. Because many navigational systems use the magnetic field direction as a

means of orientation, it is essential to track these long-term changes. Moreover, drilling programs undertaken within the oil industry rely on magnetic orientation, and these can be degraded during magnetic storms, particularly at high latitude. Many historical property boundaries are based on magnetic orientation, and knowledge of the magnetic field is needed to reconstruct or re-establish these boundaries.

The Geomagnetism Program works very closely with NOAA SWPC and AFWA to ensure complementary roles and responsibilities in delivery and dissemination of geomagnetic hazards data to the space weather community.

2010 Enacted and 2011 Program Performance

At the proposed 2011 funding level, the Geomagnetism Program will perform the following activities:

- Continue operation of 13 Geomagnetic Observatories and begin delivery of 1-second geomagnetic data to customers and users;
    - Note: one geomagnetic observatory (Del Rio, TX) was closed in 2009, because of a continued squeeze on program funding (uncovered uncontrollable costs).
- Continue collaboration with the NOAA, SWPC, and AFWA, to ensure complementary roles and responsibilities in delivery and dissemination of geomagnetic hazards data to the space weather community;
- Continue major upgrades at the Barrow, Alaska Observatory, including replacement of the primary sensor building, installation of the data-acquisition system, upgrading Internet links, and removing excess structures; and
- Provide, on the program website, operational space-weather diagnostics for measuring magnetic-storm intensities.

Geomagnetic Observatory Operations
(Estimates for 2009, $1.46 million; 2010, $1.38 million; 2011, $1.35 million)

The USGS Geomagnetism Program currently operates a network of 13 geomagnetic observatories, distributed across the United States and its territories. Data are collected continuously from each observatory by a variety of instruments housed in buildings designed to provide environmental stability and to ensure long-term baseline accuracy. Each site is visited regularly to conduct calibrations of the instruments. Data are transmitted in real time to program headquarters in Golden, Colorado, via a set of satellite and Internet linkages. The program is currently working to improve the basic infrastructure at each observatory and to improve the temporal resolution of the measurements, by increasing the sampling frequency from 1 minute to 1 second.

The 2011 performance will build upon the following 2009 accomplishments:

Geomagnetic Observatory Operations — In 2009, rigorous testing of the data resolution and timing accuracy of the provisional 1-second data was performed, and modifications to the real-time data management system in Golden were made, with the aim of preparing for fully operational 1-second data transmissions at selected observatories in 2010.

Users will benefit from these efforts in 2010, primarily through improved data quality, data timeliness, and data availability. Implementation of 1-second data transmissions will

significantly increase the size of the program's customer base, particularly among scientists studying the magnetosphere and making practical space-weather applications.

Data Processing, Management, and Dissemination
(Estimates for 2009, $0.37 million; 2010, $0.40 million; 2011, $0.40 million)

Once the data from the observatories are received in Golden, Colorado, they are subjected to initial processing and then organized for immediate transmission to both NOAA's SWPC in Boulder, Colorado, and the AFWA in Omaha, Nebraska. For longer-term studies, the magnetic data are further refined using periodic calibrations for each observatory, making them useful for research on rapid magnetic field variations and for mapping the field on a global scale. These fully calibrated, definitive data are published yearly in cooperation with foreign national geomagnetism programs working through the Intermagnet consortium. The USGS also distributes data and maps and models of the magnetic field through the *http://geomag.usgs.gov* website, which receives an average of over 30,000 web hits per day from the public.

The 2011 performance will build upon the following 2009 accomplishments:

Data Processing, Management, and Dissemination – The *Geomagnetism Production Zone*, a secure data processing facility, was established and became operational in 2009. Two real-time data products are now produced within the zone and forwarded to a USGS Web server for public display. Although much work remains before all data operations occur within the zone, this represents the first accomplishment using the desired software development model, where new systems and applications are developed and tested within the development zone (the Geomag "DevLab") and then deployed to the production zone.

Scientific and Applications Research
(Estimates for 2009, $0.23 million; 2010, $0.35 million; 2011, $0.35 million)

USGS Geomagnetism program staff conduct geomagnetic research to achieve a better understanding of basic geomagnetic processes and their effects on physical and social environments. Recent projects have included the development of a statistical framework for characterizing the long-term secular variation. The program has recently begun an analysis of the statistics of rapid magnetic field variations with the goal of characterizing them both spatially and temporally so that geomagnetic hazards can be mapped and so that risks can be quantified.

The 2011 performance will build upon the following 2009 accomplishments:

Scientific and Applications Research — A predictive model of global geomagnetic activity was published in 2009, primarily through statistical analysis of observatory data and through development of a magnetic disturbance index service. The impact of a magnetic storm depends on its size; this study helps to put magnetic storm size into historical perspective. In order to estimate the likelihood of large magnetic storms in the future, we need to know how large they have been in the past. An important and operationally useful measure of magnetic activity will be developed for display in 2010 on the program website. This will enable help to mitigate the effects of magnetic storms, by providing an accurate measure of their size as they commence and evolve. Movie-maps of past magnetic disturbance have been produced, showing where geomagnetic disturbance is most severe.

Program Performance Overview

End Outcome Goal 4.2: Improve understanding, prediction, and monitoring of natural hazards to inform decisions by civil authorities and the public to plan for, manage, and mitigate the effects of hazard events on people and property.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Efficiency and Other Output Measures										
# of stations operated **(Geomag)**	C	14	14	14	13	13	13	13	0	13

Activity: Geologic Hazards, Resources and Processes

Subactivity: **Geologic Landscape and Coastal Assessments**
Program Component: **National Cooperative Geologic Mapping Program**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1,2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
National Cooperative Geologic Mapping Program ($000)	27,724	0	28,163	-395	500	28,268	+105
Total FTE	*131*	*0*	*131*	*-1*	*0*	*130*	*-1*

1) $323 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for National Cooperative Geologic Mapping Program

Request Component	($000)	FTE
• WaterSMART Program	+500	0
TOTAL Program Changes	**+500**	**+0**

Justification of 2011 Program Changes

The 2011 budget request for the National Cooperative Geologic Mapping Program (NCGMP) is $28,268,000 and 130 FTE, a program change of +$500,000 and 0 FTE from the 2010 Enacted level.

WaterSMART Program **(+$500,000 / 0 FTE)**

The NCGMP contribution to the WaterSMART Program Initiative is to provide information on the geohydrologic framework of aquifer systems. The flagship products from the NCGMP are multi-use, three-dimensional geologic maps, which are essential to defining the vessels (aquifers) that contain the Nation's groundwater. Geologic maps provide an accurate understanding of aquifer extent and geometry that contributes to development of groundwater flow and quantity models and analysis of water budgets. Also, combining subsurface and surficial geologic map information aids in understanding surface water and groundwater interactions.

Nearly 80 percent of NCGMP projects apply geologic map information to water studies across the Nation on regional to local scales by USGS geologists and partners in State geological surveys. The Program has built-in partners in every State that will match dollar for dollar for this effort. Established State Mapping Advisory Committees bring specific knowledge of their State to benefit the strategic planning of each project conducted through this initiative.

Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

An Overview:
National Cooperative Geologic Mapping Program

- The NCGMP was created following the passage of the National Geologic Mapping Act of 1992, which was reauthorized in 1997, 1999, and 2009 (P.L. 105–36, 106–148, and 111–11). The NCGMP is the primary source of multiple-purpose geologic maps that depict the distribution of the Nation's sediment and rocks and the resources they provide.
- Provides accurate geologic maps and three- and four-dimensional frameworks that contribute to sustaining and improving the quality of life and economic vitality of the Nation and mitigating geologic hazardous events and conditions
- 15 years of successful cooperation among Federal, State, and university partners in delivering state-of-the-art digital geologic maps to the Nation in a cost-effective, timely manner.

Program Overview

Geologic maps are vital for exploring, developing, and preserving mineral, energy, and water resources; evaluating and planning for land management and environmental protection; reducing losses from natural hazards, including earthquakes, volcanoes, landslides, and other ground failures; mitigating effects of coastal and stream erosion; siting of critical facilities; and planning for basic earth science research. In short, geologic maps are the synthesis of earth science data pulling expertise from many aspects of geology, such as geochemistry, geochronology, paleontology, structural geology, stratigraphy, and geophysics. Geologic maps provide subsurface data important in the development of models that conceptualize ground water flow, mineral deposition, and earthquake shaking to name a few.

Program priorities are outlined in the National Geologic Mapping Act of 1992 and in the program's 5-Year Plan for 2007-2011. The NCGMP 5-Year Plan has three goals:

- Produce high-quality, multi-purpose digital geologic maps and accompanying databases and reports to solve diverse land-use problems in high-priority areas. Develop three-dimensional geologic frameworks that extend into the subsurface for use in a variety of predictive models, such as ground-water flow, seismic shaking, landslide probabilities, landscape change, and ecosystem health. Measures under this goal deal with increasing regional geologic map coverage of the United States, promoting use of geologic maps by the NPS, water resource managers, and in the mitigation of natural hazards, as well as documenting the systematic analyses and investigations completed.

- Make geologic map information more accessible to the public by providing geologic maps, reports, and databases in a variety of digital formats. Preserve and make accessible the extensive USGS paleontologic collections and accompanying databases. Measures under this goal document the maps and reports that are made accessible on the internet through the National Geologic Map Database (*http://ngmdb.usgs.gov/*) and the information provided to our customers through formal workshops and training.

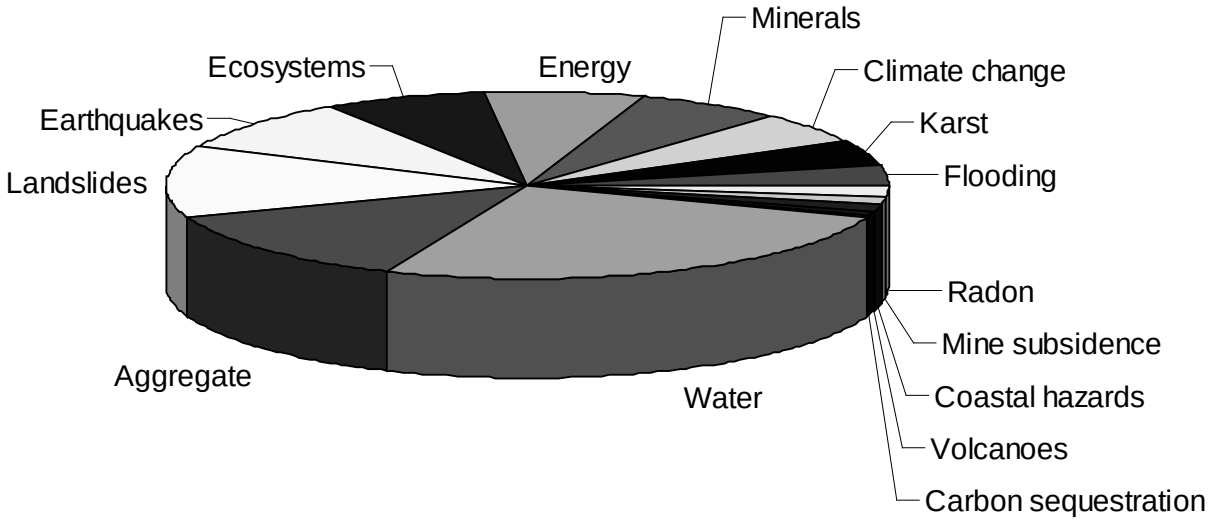
- Ensure that the NCGMP will have the capabilities and work force to meet the geologic mapping future needs of the Nation. Measures include documenting how students trained through the EDMAP component of the program use their mapping experience to further their geoscience education and careers.

The NCGMP priorities are reviewed annually by a congressionally mandated Federal Advisory Committee (FAC), which includes representatives from the Department of the Interior, U.S. Department of Energy (DOE), U.S. Department of Agriculture (USDA), U.S. Environmental

Protection Agency (EPA), State geological surveys, academia, and the private sector. Progress and status reports on the NCGMP are prepared for the Secretary of the Interior to deliver to the Committee on Resources of the House of Representatives and the Committee on Energy and Natural Resources of the Senate. In addition, State Mapping Advisory Committees in 48 States meet each year to prioritize local geologic mapping needs and assist USGS managers in modifying and prioritizing long-range plans. These priorities are based on customer needs for the maps.

In 1987, geologic maps had five primary applications: oil and gas, metals, industrial minerals, ground water, and coal, listed in decreasing order. Since that time, the number of applications has increased to 15, as can be seen in the figure below.

Societal Applications of Federal and State Geologic Mapping



The Energy Policy Act of 2005 contains section 2011, preservation of geological and geophysical data. This section calls for the establishment of the National Geological and Geophysical Data Preservation Program (NGGDPP) within the USGS, which is to “archive geologic, geophysical, and engineering data, maps, well logs, and samples [and] provide a national catalog of such archival material.” In addition to its duties under the National Geologic Mapping Act, the NCGMP FAC is charged by this act to develop guidelines and procedures for and to review progress of the NGGDPP.

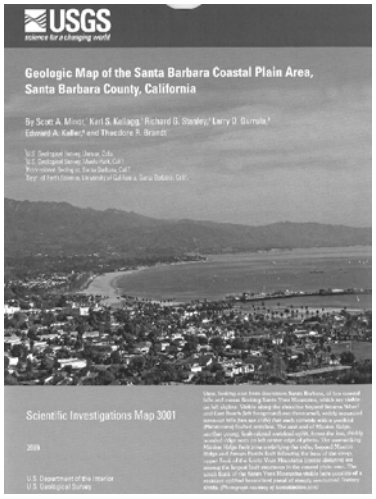
The **Central Great Lakes Geologic Mapping Coalition** is a Federal-State partnership created to produce urgently needed, detailed, three-dimensional surficial materials maps of the Great Lakes States. The States in this region have a similar geologic heritage and need to address common societal issues about land and water resources, the environment, and geologic hazards. Geologic maps produced by the project provide a foundation for making economic and environmental decisions related to ground water resources, land, and other natural resources in the Central Great Lakes region.

2010 and 2011 Program Performance

The NCGMP carries out the Mapping Act through three main program components: FEDMAP, STATEMAP, and EDMAP. Each year, panels that include scientists from Federal and State governments, and academia critically review all work plans that are submitted to the three components.

NCGMP-funded projects provide support for all of the USGS Science Strategies. Approximately 70 percent of FEDMAP projects and 95 percent of STATEMAP projects contribute to the solution of water issues. The USGS can not successfully meet the goals for the National Water Census outlined in its strategic plan without using information from geologic maps and related information provided by NCGMP scientists because the geologic formations mapped in the subsurface define the shape of the aquifers (the vessels that hold the ground water), how much water can be stored in them, and parameters for water movement through the ground. For example, geologic data gathered about the Arbuckle-Simpson aquifer in Oklahoma will be incorporated into USGS Water Resources Discipline's multi-layer ground-water model of the region.

Many NCGMP-funded projects also provide critical information for predicting and mitigating natural hazards, such as landslides, earthquakes, and volcanoes. For example, in the multi-county area of southern California where recent forest fires have destroyed 800,000 acres, the USGS has provided FEMA with landslide risk assessment maps. These maps are being used to help make decisions on road closures and home evacuations. The program also funds a project that is constructing three-dimensional maps through time of earthquake-induced ground shaking. These maps, based on accurate geologic parameters, offer enormous help in earthquake disaster planning and mitigation efforts.

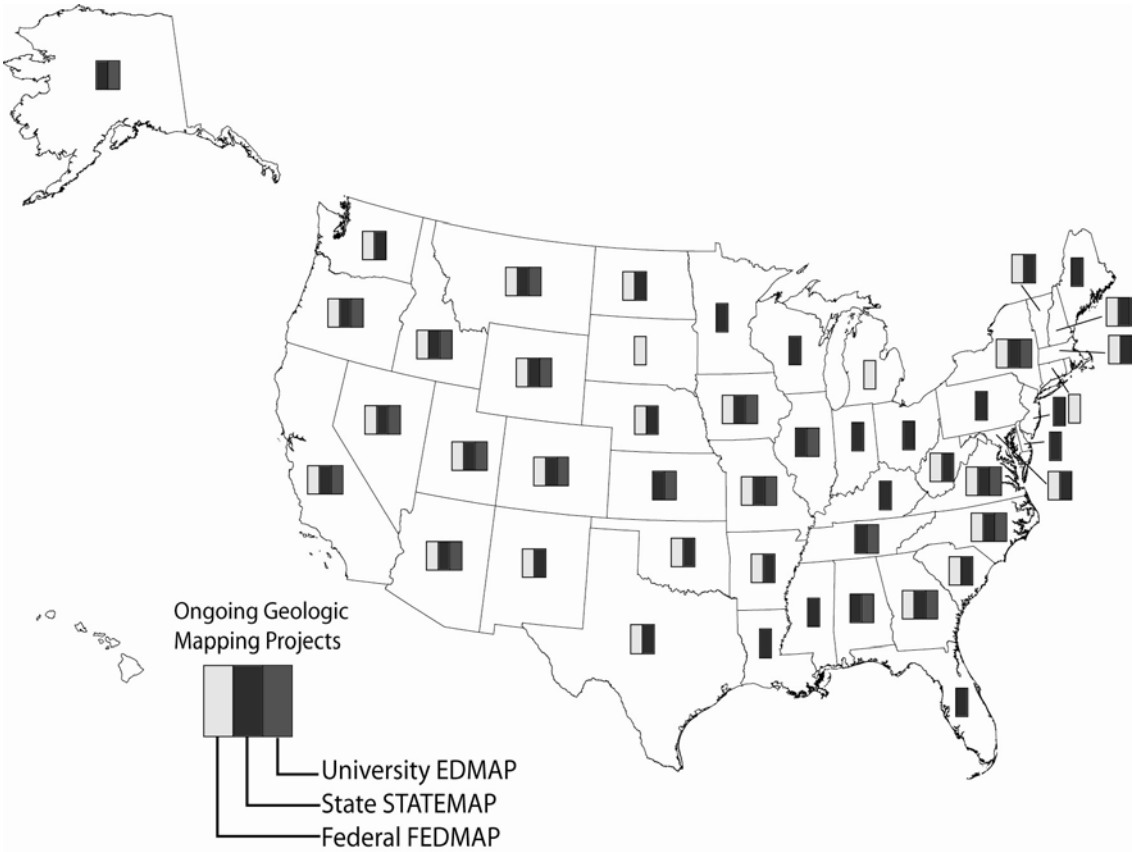


The Geologic Map of the Santa Barbara Coastal Plain Area (USGS Scientific Investigations Map 3001), which shows that the seismicity in the area is related to structures in the Santa Barbara fold and thrust belt.

Through a Science in the Parks effort, and at the request of the NPS, in 2010 the USGS will complete the geologic map of Big Bend National Park. The NPS ranks this the second most important national park to receive new geologic mapping. The map is greatly needed for park managers to understand and make decisions related to potential toxic concentrations of heavy metals in the groundwater, springs, and surface water of the park.

The NCGMP anticipates that approximately 44 State geologic surveys and 40 universities will receive financial support in 2010 from NCGMP through the STATEMAP and EDMAP grant programs. These projects will produce over 400 new geologic maps and train approximately 45 students.

National Geologic Mapping Act: Successful Federal-State-University Partnering



The FEDMAP Component — Federal Geologic Mapping Science and Applications

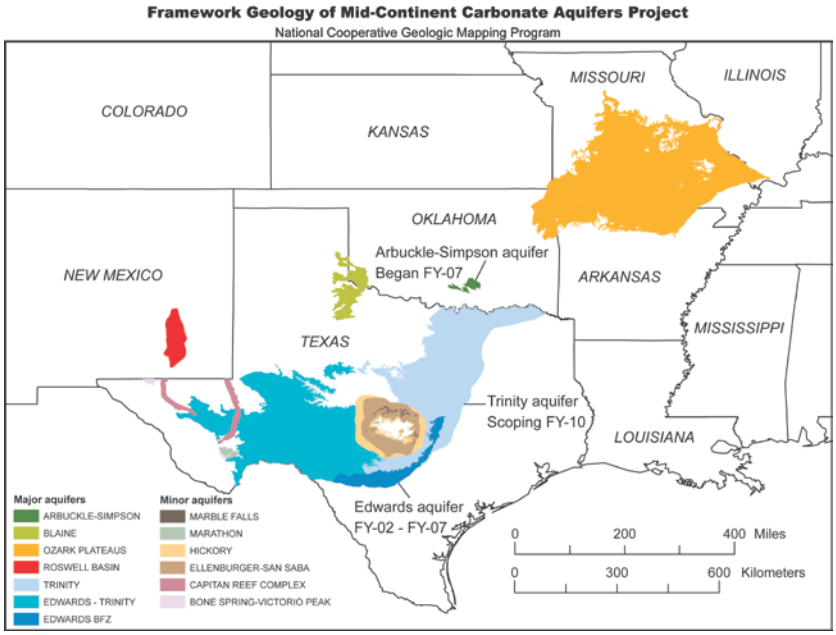
(Estimates for 2009, $18.7 million; 2010, $18.9 million; 2011, $18.7 million)

The FEDMAP component currently supports, totally or in part, 32 regional geologic mapping and synthesis projects that cross jurisdictional boundaries or involve work on Federal lands. These projects are located primarily within three regional teams of the USGS: Western Earth Surface Processes Team, Central Earth Surface Processes Team, and Eastern Earth Surface Processes Team. The NCGMP also funds interdisciplinary projects with the MRP, EHP, LHP, the Ground Water Resources Program, and the Global Change Program. Most of these projects have a lifespan of approximately 5 years. In 2009, studies were undertaken in 38 States. New and ongoing geologic

> "The National Park Service Geologic Resources Division and Chickasaw National Recreation Area will utilize the new geologic map of the park as a tool for a variety of resource management issues, ranging from water quality and availability to the location of sensitive paleontological resources. The completion of the park map also satisfies congressionally mandated deliverables under the NPS Natural Resource Challenge's Geologic Resources Inventory."
>
> Bruce Heise
> Geologist, Geologic Resources Division, National Park Service

mapping work plans are evaluated annually by a FEDMAP Review Panel, which includes representatives from State geological surveys, the NPS, and USGS scientists with diverse scientific backgrounds. The program also partially supports a number of geochronology and other common-use laboratories in the Geologic Discipline and the National Geologic Map Database Project (NGMDP), which represents a major cooperative effort with the Association of American State Geologists to serve information about all geologic maps produced in the United States.

FEDMAP Accomplishment



Geologic mapping of the Edwards and Trinity aquifers in central Texas have improved our understanding of the hydrologic connection between these two aquifers. Similar studies on the geology of the Arbuckle-Simpson aquifer system in southern Oklahoma have provided geologic frameworks critical to the completion of a 5-year, State-sponsored Arbuckle-Simpson Hydrology Study, which has produced a multilayer groundwater flow model.

The NGMDP is an ongoing effort with State geological surveys, universities, the Canadian Geological Survey, and the Consejo de Recursos Minerales, Mexico, to present all geologic mapping data from North America on one web site and with a common set of map standards such as geologic map symbols, colors, and patterns. Additionally, users can access information on current geologic mapping activities and the proper use of geologic names. The project's web site serves more than 40,000 users per month.

Through the Science in the Parks effort, the NCGMP is the principal USGS partner coordinating and prioritizing geologic mapping studies with the NPS. Projects are developed and selected jointly by the NPS and the USGS to merge the earth science information needs of individual parks with the geologic mapping mission of the USGS. The resulting geologic data are made available in digital and standard formats that are needed for NPS land-use management, educational outreach, inventory, and monitoring of natural resources. NCGMP-funded projects also work with other Federal land management agencies (e.g., FWS, BLM, and the USFS).

Over the past few years, geologists within the NCGMP have been working to advance and improve the production of geologic maps through the use of new field mapping techniques that streamline the process from data collection to map production. The NCGMP has established ambitious targets to make the process even more efficient.

The STATEMAP Component — Serving State Priorities for National Needs

(Estimates for 2009, $8.4 million; 2010, $8.6 million; 2011, $8.8 million)

The STATEMAP component currently supports geologic mapping studies by 45 State geological surveys through a competitive grant program that matches every Federal dollar with a State dollar. Since 1993, more than $74 million has been matched by 48 States. Mapping priorities are determined with the help of State Mapping Advisory Committees in each State, which include representatives from all levels of government, the private sector, academia, and industry. Currently, more than 500 individuals offer their time on these committees to prioritize geologic mapping needs.

STATEMAP Endorsement

The STATEMAP program provides the resources we need and are unable to provide ourselves. The online resource provides the ability to quickly retrieve geologic information, define areas of potential geologic instability, locate potential materials sources, and provide for a better understanding of the geologic conditions in and near our projects. The STATEMAP program is a very valuable resource for us, for our consultants and for private development as well.

William Capaul
Idaho Department of Transportation
October 2009

Some recent STATEMAP accomplishments include:

- Geologic maps produced by the Delaware Geological Survey were vital in determining the hydrogeology and engineering geology of an area in the central part of the State that was needed to engineer wastewater disposal. The geologic maps determined the geologic units most favorable for such a public project.

- Geographic information system-based geologic map projects by the Florida Geological Survey were used to accurately define and characterize confining materials that separate two aquifer systems. This was important to protect the source water used for domestic use from contaminated supplies in a surface aquifer.

- Geologic maps produced by the Idaho Geological Survey were important to the Idaho Department of Transportation for engineering highways in developing corridors. The maps were used to understand the geotechnical properties of the land being developed, to identify sources of aggregate for construction materials, and to identify landslide areas for areas prone to this hazard.

The EDMAP Component — Training the Next Generation of Geoscientists

(Estimates for 2009, $0.6 million; 2010, $0.7 million; 2011, $0.7 million)

The EDMAP component supports the training of a new generation of geologic mappers in universities and colleges through a competitive matching-fund grant program. Since EDMAP's inception in 1996, more than $5.0 million from the NCGMP has supported geologic mapping efforts of more than 700 students working with more than 220 professors at 136 universities in 44 States, the District of Columbia, and Puerto Rico. Funds for graduate projects are available up to $15,000 and undergraduate projects, up to $7,500. These funds are

Response to EDMAP Student Survey:

"The EDMAP opportunity was a great chance for sustained fieldwork, which may have been an advantage when searching for my first job after college. My first job involved a lot of fieldwork".

Krista Anderson
University of Massachusetts
June 2009

used to cover field expenses and map production but not faculty salaries. The sponsoring college or university matches the EDMAP funding.

In 2009, the NCGMP continued a career study of EDMAP students that was begun in 2004. Students are sent a questionnaire 3 years after completion of their EDMAP experience. The results clearly demonstrate that EDMAP students: fall well above the national average for pursuing advanced academic degrees in the geoscience field, easily obtain geoscience positions due to the knowledge gained through the EDMAP experience, and (frequently use the geologic mapping skills gained through the EDMAP.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of the U.S. that is covered by at least one geologic map and is available to the public through the National Geologic Map Data Base **(NCGMP)**	C	44.13%	45.51%	47.71%	48.9%	48.9%	50%	51%	+1%	52%
Efficiency and Other Output Measures										
Annual production of geologic maps for the Nation (summed and represented as a % of US), made available to the public through the National Geologic Map Data Base **(NCGMP)**	A	5.57%	5.37%	4.15%	2.9%	2.9%	2%	2%	0%	2%
Total projected cost ($000)		**UNK**	**UNK**	**23,458**	**23,460**	**24,425**	**24,812**	**24,904**	**+92**	**24,904**
Actual projected cost per square mile (whole dollars)		**UNK**	**UNK**	**1,750**	**1,750**	**1,750**	**1,750**	**1,750**	**0**	**1,750**

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Activity: Geologic Hazards, Resources and Processes

Subactivity: **Geologic Landscape and Coastal Assessments**
Program Component: **Coastal and Marine Geology**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2009 (+/-)
Coastal and Marine Geology ($000)	44,657	0	46,188	-871	+4,000	49,317	3,129
Total FTE	*228*	*0*	*227*	*-2*	*+8*	*233*	*+6*

1) $472 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Coastal and Marine Geology Program

Request Component	($000)	FTE
• Coastal and Marine Spatial Planning	+4,000	+8
TOTAL Program Changes	**+4,000**	**+8**

Justification of 2011 Program Changes

The 2011 budget request for the Coastal and Marine Geology Program (CMGP) is $49,317,000 and 233 FTE, a program change of +$4,000,000 and +8 FTE from the 2010 Enacted level.

Coastal and Marine Spatial Planning (+$4,000,000 / 8 FTE)

The USGS will actively engage with other Interior bureaus and federal agencies in implementation of the “Framework for Effective Coastal and Marine Spatial Planning”. This framework for Coastal and Marine Spatial Planning (CMSP) includes implementation guidance for phased and collaborative development, including Federal, State, tribal, and other partners; to develop capacity, build on existing efforts, and leverage and gain efficiencies from lessons learned. The funds provided through this increase would support engagement of USGS and other Interior bureaus in the incorporation of CMSP activities within the ocean governance structure and the development of a Strategic Action Plan for CMSP implementation. This effort will enable USGS and Interior bureau engagement in planning and implementation at both national and regional levels ensuring regional responsiveness and national consistency in objectives, performance measures, and guidance and standards relevant to a national information management system.

While supporting overarching CMSP implementation, the funding provided will also support USGS and Interior in development of a National Information Management System (NIMS) as a

element of CMSP implementation. The USGS will provide knowledge and systems for collaborative development of the NIMS and CMSP portal(s); further the development and adoption of data standards consistent with government-wide information quality standards; and identify and begin development of new tools or models needed for CMSP in all regions. The results of this collaborative effort will include a prototype CMSP portal and strategic guidance for continued NIMS development within the Strategic Action Plan.

Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

Program Overview

Program objectives spanning the thematic program components include:

- Characterization of the coastal geological setting, processes, and change at regional or system scales to provide the framework understanding for management and policy in response to a range of issues. Framework development and synthesis of geologic information and understanding is the foundation for USGS research activities to understand and model the physical processes that affect coastal and marine systems and the resulting environmental, hazard, and resource implications for human and environmental health, economic growth, public safety, and resource use, protection, and management.

- Development of regional and national hazard, resource and environmental assessments of coastal and marine conditions, change and vulnerability to human and natural processes. Regional geological framework development and topical research on geological processes provides the foundation for development of assessment products.

- Development of broadly applicable models of coastal and marine evolution and change. Geologic framework development and process understanding provides the basis for development and evaluation of models. Application to specific issues and settings and expanding the range of relevant applications is supported by regional information and targeted studies.

Overall direction of CMGP activities is established by the Comprehensive National Coastal Program Plan which provides overall direction, goals and objectives for a five-year period. The plan reflects internal and external inputs and periodic reviews of the program and program elements by the National Academy of Science. The CMGP is broadly directed by the objectives of the National Coastal Program Plan (2003) submitted to Congress by the USGS. The overall goals of this program are to provide scientific information, knowledge, and tools required to ensure that land

An Overview: Coastal and Marine Geology Program

- Maintains and applies capabilities in marine geology, geophysics, geochemistry and oceanography to provide information and research products on geologic conditions and processes critical to the management of the Nation's coastal and marine environments.

- Addresses a broad suite of national issues in the thematic areas of natural hazards, environmental quality and human health, and natural resources requiring credible and objective scientific data, information, and understanding.

- Develops, maintains, and delivers information, technologies, and products that provide Federal, State, and local agencies and the public the authoritative, scientific basis for regulating, managing, and protecting the Nation's coastal and marine resources and communities.

and resource use decisions, management practices, and development in the coastal zone and adjacent watersheds can be evaluated with a complete understanding of the effects on coastal ecosystems and communities; and provide a full assessment of the vulnerability of coastal and marine ecosystems and communities to natural and human-driven changes.

The CMGP supports Interior's goal to improve the understanding of national ecosystems and resources through integrated interdisciplinary assessment. Goals for project and program outputs are established as part of the program planning process and engagement with the USGS Regional structure.

The CMGP develops and implements national, regional, and topical studies that advance knowledge relevant to national issues. Program activities are developed in response to long-term program objectives, partner needs, and potential to leverage USGS resources with partner resources to meet shared objectives. Leveraging or cost-sharing provides partners access to unique USGS capabilities while enhancing the cost-effectiveness of USGS mission activities. Historically, partners provide seven to ten percent of funding for program activities, with significant in-kind contributions provided through collaborative studies to respond to critical needs identified by stakeholders. This practice ensures that study products have immediate application while advancing long-term program objectives. Regional studies are designed to provide essential framework information to Federal, State, and local managers with respect to specific issues and topics as well as providing broadly applicable information products. Topical studies, often implemented within regional efforts, are designed to develop fundamental information that has broad applicability. Synthesis of regional and topical studies provides the basis for national assessments and products. Project work plans submitted to the CMGP are reviewed annually by internal and external scientists and managers knowledgeable in the area of proposed and ongoing work and provide guidance that informs program directions and implementation.

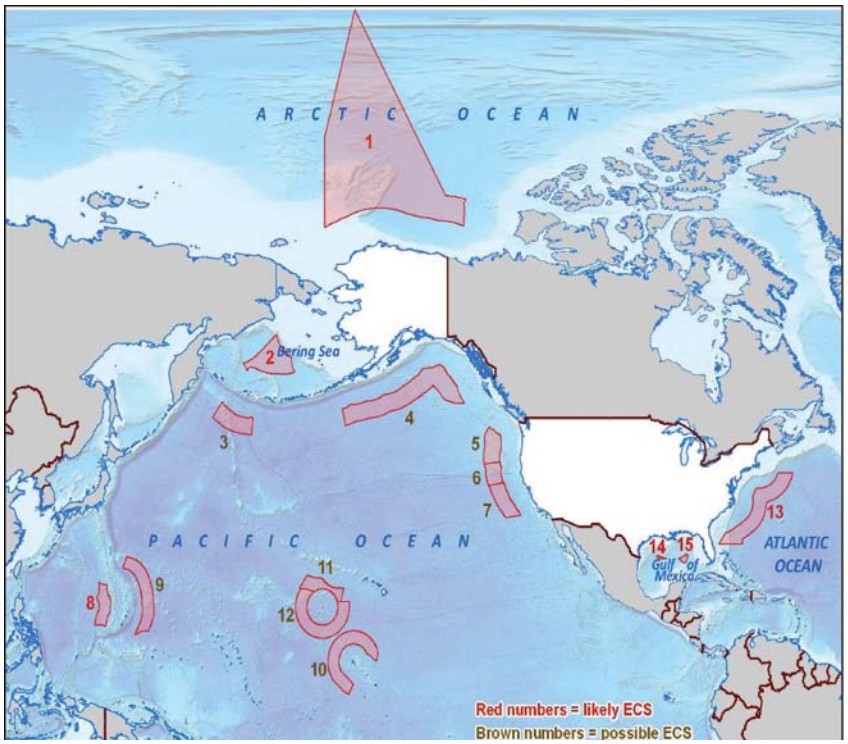
The CMGP supports research projects at the Coastal and Marine Geology centers in Woods Hole, Massachusetts, St. Petersburg, Florida, and Santa Cruz, California. The CMGP also uses the expertise found in other USGS science centers as well as external cooperators.

2010 Enacted and 2011 Program Performance

For 2011, the program performance will be near or at established levels. With increased stakeholder input there will be merit-based selection for continuation of integrated studies of coastal systems from California and the Gulf of Mexico to the Great Lakes and the Pacific Northwest. Lessons learned from hazard and environmental studies in the southeastern and mid-Atlantic United States during 2009 and 2010 will be applied in the Long Island and Northeast seashores.

As part of the interagency effort for delineating U.S. limits of the Extended Continental Shelf (ECS), the USGS is supporting departmental priorities in this effort. During 2008, the USGS and members of an Interagency Task Force on the ECS initiated data collection on the Arctic in conjunction with Canada. The USGS provides essential capabilities to conduct substantial and targeted seafloor mapping activities, using sophisticated equipment, scientists and field data collection crew members to collect and interpret large-volume geophysical and geological data. the USGS's Federal leadership in geological characterization is critical to the establishment of ECS limits. Activities in 2011 will address priorities of the Interagency Task Force on the ECS and will include field programs for data collection as well as data analysis and report writing associated with the summer 2009 and 2010 research cruises in the Arctic.

Program changes will have a modest impact on 2011 performance. The number of interactions with partners will increase as the President's National Ocean Policy is implemented. At this level, the increase in the number of gigabytes of LiDAR data collected (+300 annually) will increase over 2009. The number of systematic analyses will increase to 210 annually.



Areas of interest where the United States might have an extended continental shelf beyond 200 nautical miles. (Source: continentalshelf.gov)

Highlights of projects in 2009 and 2010 include:

Tsunami Hazards -The USGS provided assessments of tsunami hazards along the U.S. Atlantic and Gulf of Mexico for use by the U.S. Nuclear Regulatory Commission (NRC) to guide evaluation of applications for new reactors, and for use by power utilities for their applications. Fundamental research into potential tsunami sources and their probability of activity has resulted in an international scientific journal with 8 original contributions. This volume has already become a standard in the international science community. Coastal & Marine Geology (CMG) scientists have provided specialized technical assistance to the NRC in the area of tsunami hazard analysis. In coordination with the USGS Earthquake Hazards Program, work with the New Reactors Office of the NRC entails hydrologic review of proposed new nuclear power plants along the Gulf Coast, Atlantic Seaboard and Great Lakes. A seafloor survey of the continental slope from south of Cape Hatteras to the Canadian border has resulted in an unprecedented detailed view of the seafloor. The new data show multitude of landslides of different sizes, some of which can cause tsunamis, and investigates the factors that control the development of submarine landslides and canyons.

Coastal Sensitivity to Sea-Level Rise -The USGS was a principal contributor to Synthesis and Assessment Product (SAP) 4.1, developed as part of the U.S. Climate Change Science Program over the period 2005-2009. The report examines potential effects of sea-level rise from climate change during the twenty-first century, with a focus on the mid-Atlantic coast of the United States. The SAP describes the physical environments; potential changes to coastal environments, wetlands, and vulnerable species; societal impacts and implications of sea-level rise; decisions that may be sensitive to sea-level rise; opportunities for adaptation; and barriers to adaptation. The SAP also outlines the policy context in the mid-Atlantic region and describes the implications of sea-level rise impacts for other regions of the United States. Finally, the SAP discusses ways natural and social science research can improve understanding and prediction of potential impacts to aid planning and decision making. A brochure of highlights and key findings was published and distributed widely to federal, state, and local decision makers,

academic institutions, and non-governmental organizations.
http://www.globalchange.gov/publications/reports/scientific-assessments/saps/sap4-1

Threatened Coral Species Located In Dry Tortugas National Park - During the first fieldwork mission of the new Coral Reef Ecosystem Studies project, benthic habitat surveys were performed in Dry Tortugas National Park (DRTO), Florida, using the Deep Along-Track Reef Imaging System. Nearly 460,000 color digital images were acquired in eight days, covering 163 km of seafloor. To date, 50 colonies of staghorn coral have been identified in the imagery, many of which were unknown to the NPS. Most of these colonies are located outside of the Research Natural Area, a special marine reserve within DRTO intended to restore ecological integrity by minimizing human influences. Considered to be one of the three most important Caribbean corals, staghorn coral was listed as "threatened" under the Endangered Species Act on May 4, 2006. This improved information on the occurrence of staghorn coral in the Dry Tortugas will be useful for developing management strategies for this threatened species. The USGS also documented fine-scale habitat usage patterns of three turtle species that have been outfitted with satellite tags.

Gas Hydrates - During 2009, a highly successful public-private gas-hydrate drilling program was undertaken in the Gulf of Mexico. USGS scientists served as chair of the site selection team, as co-chief of the drilling program, and in other advisory roles to the Chevron-led Joint Industry Project. The results demonstrate that marine gas hydrates do occur in sufficiently high saturations. Additionally, the USGS began a new study of the potential contributions of gas hydrates in permafrost to climate change. Evidence has suggested permafrost melting could (or already has) caused massive gas seeps along the North Slope of Alaska and offshore on the inner continental shelf. The USGS and University of Alaska (Fairbanks), with support from the DOE, undertook a comprehensive study of a seep site in Lake Qalluuraq, about 90 km south of Barrow, that will help unravel the history of methane emissions. The USGS is planning to sample similar seeps on the inner shelf of the Beaufort Sea during 2010.

California Seafloor Mapping – The USGS is a key partner with the State of California in the California Seafloor Mapping Program (CSMP), with the goal of comprehensively mapping the bathymetry, benthic habitats, and geology of all state waters. The CSMP mapping addresses several important needs: characterization of benthic habitats; fisheries management, including design of marine protected areas and monitoring of essential fish habitat; development of bathymetry and habitat baselines for monitoring environmental change; understanding coastal processes, including circulation and sediment/contaminant transport and budgets; regional sediment management; forecasting storm inundation and coastal erosion: assessing sea-level rise and other climate change impacts; improved navigation and commerce; evaluation of sites for nearshore and offshore infrastructure, including renewable energy; and assessment of coastal earthquake and tsunami hazards. During 2010, the USGS will look at lessons learned and best user-interfaces for Coastal and Marine Spatial Planning information and delivery needs.

Highlights of proposed work in 2011 include:

Alternative Offshore Energy – The USGS coastal and marine experts will work in partnership with other Interior Bureaus (NPS, Minerals Management Service (MMS), and FWS) on identifying and addressing gaps in regional information needed to assess potential impacts of siting and installation of offshore energy systems and associated cables for electrical transmission to coastal electrical power distribution stations. Marine areas of interest include

the Mid-Atlantic, and the Pacific Northwest. Cooperative planning and project development will engage regional ocean alliances such as the Mid-Atlantic Research Consortium for Oceanography and Northeast Regional Ocean Council; which have identified critical gaps in seafloor mapping in the Hudson River Canyon, Gulf of Maine, the series of sounds along Connecticut, Rhode Island and southern Cape Cod, and near-coastal environments around barrier islands associated with National Seashore and National Wildlife Refuges.

Extended Continental Shelf (ECS) – As a member of the U.S. ECS Task Force, chaired by the DOS, USGS would continue to collect scientific data about the legal continental shelf encompassing the oceanic basins in the Atlantic and Pacific. The USGS has completed two successful missions in the Arctic with NOAA and Canadian partners, determining sediment thicknesses and better definition of the shelf. During 2010, the USGS will again be onboard the *US Coast Guard Cutter Healy* (a U.S. ice breaker) as part of a team with the *Canadian Coast Guard Cutter Louis S. St. Laurent* (a Canadian icebreaker). This experimental approach allowed the crew on the *Healy* to map the seafloor while the crew on the *Louis* (which traveled through a straight and open path cut through the ice by the *Healy*) collected multi-channel seismic reflection and refraction data for determining the thickness of sediment. This collaboration has been an efficient and effective way to map an area of unknown geologic evolution and natural resources where U.S. and Canadian interests overlap.

Puget Sound Response to Dam Removal -The Nisqually Tribe, the FWS and USGS are collaborating to examine how nearshore habitat structure and hydrodynamic processes respond to the largest dike removal project in Puget Sound at the Nisqually River Delta. The Nisqually Tribe and Nisqually National Wildlife Refuge provide guidance, study design, operational resources, and financial support, while the USGS contributes scientific input, study implementation, and interpretations. The USGS would continue systematic collection of a comprehensive data set of nearshore ecosystem metrics following dike removal to detect changes to biophysical processes. USGS will develop models that predict the evolution and interaction of geomorphology, vegetation, food-resources, and bird and salmon habitat use on 750 acres of recovered salt marsh.

Northern Gulf of Mexico Ecosystem Change and Hazard Susceptibility- Working with the NPS and FWS, the USGS would characterize the geologic framework and bathymetry of barrier islands and low-lying areas off the coast of Mississippi and Louisiana, Building upon successful data collection with U.S. Army Corps of Engineers and Gulf Coast states, the USGS would assemble a high-resolution assessment of the topography, bathymetry and stratigraphy of these fragile ecosystems. The project would assemble a regional synthesis of northern Gulf Coast ecosystem and human community structure to forecast evolution of this landscape over the next century related to regular natural processes, from changes induced by human development, and severe storms in the the coming century.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of regional and major topical studies for which interpretive and synthesis products are cited by identified partners and users within 3 years of study completion **(C&M)**	A	80%	80%	80%	80%	80%	80%	80%	0%	85%
Efficiency and Other Output Measures										
Cost of collection and processing of LiDAR data for coastal characterization and impact assessments **(C&M)**	C	.55	.57	.50	.45	.44	.39	.32	-0.7	.31
# of gigabytes of LiDAR data collected annually **(C&M)**	A	UNK	UNK	UNK	100	100	300	300	0	300
# of systematic analyses and investigations completed **(C&M)**	A	8	218	200	180	200	200	210	+10	225
Total projected cost ($000)		**36,000**	**33,745**	**34,549**	**35,000**	**35,000**	**43,000**	**46,000**	**+3,000**	**46,000**
Actual projected cost per analysis (whole dollars)		**UNK**	**155,000**	**173,000**	**205,880**	**175,000**	**215,000**	**219,000**	**+4,000**	**205,000**
# of systematic analyses and investigations completed for Coastal and Marine Spatial Planning **(C&M)**	A	UNK	UNK	UNK	UNK	UNK	UNK	10	+10	15

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Activity: Geologic Hazards, Resources, and Processes

Subactivity: **Geologic Resource Assessments**
Program Component: **Mineral Resources**

	2009 Enacted	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Mineral Resources ($000)	52,427	0	53,780	-858	-400	52,522	-1,258
Total FTE	*345*	*0*	*344*	*-3*	*0*	*341*	*-3*

1) $984 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Mineral Resources Program

Request Component	($000)	FTE
• Increasing Resilience to Natural Hazards	+250	0
• Mineral Resource Assessment for Nye County, NV	-650	0
TOTAL Program Changes	**-400**	**0**

Justification of 2011 Program Changes

The 2011 budget request for the Mineral Resources Program (MRP) is $52,522,000 and 341 FTE, a program change of -$400,000 and 0 FTE from the 2010 Enacted level.

Increasing Resilience to Natural Hazards **(+$250,000 / 0 FTE)**

The MRP will work with other USGS programs and emergency responders to analyze demand for and supply of mineral commodities and other materials required to rebuild damaged infrastructure and analyze the potential magnitude and extend of adverse economic impacts resulting from material shortages and assess the threat posed by large volumes of contaminated waters, soils, sediments, and other materials produced by natural and anthropogenic disasters. Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

Mineral Resource Assessment for Nye County, NV **(-$650,000 / 0 FTE)**

The reduction eliminates unrequested congressional funding that does not address the highest priority science needs. This will keep the core program intact while allowing the USGS to make the best use of available resources. These funds were used to conduct a mineral resource assessment of Federal lands in Nye County, Nevada in collaboration with the University of

Nevada, Las Vegas and the Nevada Bureau of Mines and Geology. This activity will be discontinued in 2011.

Program Overview

An Overview:
Mineral Resources Program

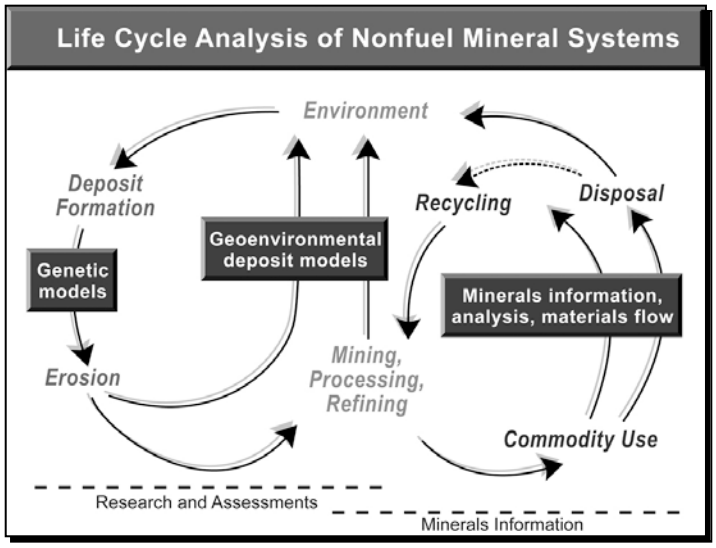
- The Federal Land Policy and Management Act of 1976 requires the USGS to "conduct mineral surveys of public lands to support the designation of Wilderness Areas . . . Prior to BLM making any recommendation for the designation of any area as wilderness, the Secretary of the Interior shall cause minerals surveys to be conducted by the USGS."
- USGS has responsibilities deriving from the Minerals Policy Act of 1970 and the National Materials and Minerals Policy, Research, and Development Act of 1980.
- USGS is the Federal source for current and reliable research and information about both domestic and international mineral resources and the consequences of their development.
- USGS works with partners and customers in defining priorities and carrying out mineral resource data collection and research that supports the needs of decision makers in land management, defense, national security, and economic policy.

Nonfuel Minerals in U.S. Economy

The United States is the world's largest user of mineral commodities. Nonfuel mineral materials such as copper, potash, and platinum group metals underpin significant portions of the U.S. economy and influence decisions related to energy and national security. Processed materials of mineral origin accounted for an estimated $454 billion in the U.S. economy in 2009, a significant decrease below the estimated $609 billion for 2008, likely reflecting the global economic downturn and demonstrating the close connection between the overall economy and the use of mineral materials. In 2009, U.S. manufacturers and consumers of mineral products depended on other countries for 100 percent of 19 mineral commodities and for more than 50 percent of 38 mineral commodities that are critical to the U.S. economy.

Copper—An Important Nonfuel Mineral

- Copper is a part of our everyday lives—it's many uses include building construction, power generation and transmission, electronic product manufacturing, production of industrial machinery and transportation vehicles, and plumbing, heating and cooling.
- MRP-supported studies highlight how and where copper resources are formed, how copper resources interact with the environment, and trends in supply of and demand for copper resources in domestic and international markets.
- Copper is one of 80 different commodities collected by MRP.
- The goals of the MRP are to understand the mineral endowment of the Nation, the relationships between ore bearing rock and human and ecosystem health, and the influence of minerals to economics and security to a global economy.
- Recent studies and data collection activities support the needs of decision makers in land management, defense, national security, and economic policy.
- The USGS is the Nation's only Federal source for current and reliable research and information about both domestic and international mineral resources and the consequences of their development.



Key partners include other Interior bureaus, Defense logistics and stockpile agencies, the intelligence community, and the Federal Reserve, as well as State and local government agencies and private organizations with interests in managing mineral lands and anticipating future mineral supply. These partnerships succeed because they represent shared commitment to providing the best possible information and research to support decisions affecting mineral resources. For example, domestic mineral production data reported by the USGS are supplied on a voluntary basis by 18,000 establishments who complete monthly, quarterly, or annual data reports. These data become part of the basis on which the Board of Governors of the Federal Reserve prepares its index of industrial production, a principal economic indicator. Similarly, the USGS partners with geological surveys around the world to conduct research resulting in estimates of global distribution of undiscovered mineral resources, the basis of future mineral supply.

The MRP is the sole Federal provider of scientific information for objective resource assessments and unbiased research results on mineral potential, production, consumption, and environmental effects. Life cycle analysis of nonfuel mineral systems (see figure above) demonstrates the connections between various natural and anthropogenic processes through which minerals are made available to sustain developed societies.

In its most recent review of the MRP (2003), the NRC identified four Federal roles in mineral science and engineering:

- an unbiased national source of science and information;
- basic research on mineral resources;
- advisory; and
- international (undertaking or supporting international activities that are in the national interest).

The MRP addresses these four roles through work in two functions:

- a research and assessment function that provides information for land planners and decision makers about where mineral commodities are known and suspected in the Earth's crust; and
- a minerals information function that collects, analyzes, and disseminates data that describe current production and consumption of about 100 mineral commodities, both domestically and internationally for approximately 180 countries.

> "Your description of the need for fundamental research on the mechanisms of mineral formation as it impacts distribution and access to scarce materials has impacted our thinking about the possible policy outcomes of our study. I'm looking forward to having your input to the working group in the future."
>
> Robert L. Jaffe
>
> Morningstar Professor of Physics and MacVicar Faculty Fellow
> Center for Theoretical Physics
> Massachusetts Institute of Technology
>
> May 2009

Each function meets the needs of different parts of the community of mineral resource information users, including:

- Federal, State, and local land managers;
- Federal, State, and international departments and agencies concerned with materials availability, defense, security, the economy, trade, environmental management, human health and safety;
- private sector companies concerned with materials availability, defense, security, the economy, trade, environmental management, human health and safety; academic institutions;
- policymakers in the U.S. Congress, and State and local governments; and
- the general public.

> "I am working on some naturally occurring asbestos issues on the National Forest Lands in Northern California. … *The Geology of Asbestos in the United States and its Practical Applications* … is a great way to get everyone on the team (geologist or not) to understand how and what asbestos really is and where to find it.
>
> Angie L. Bell
> Geologist, Klamath National Forest
>
> February 2009

Together these activities provide information ranging from that required for land planning decisions on specific management units to that required for national and international economic decisions. Results of MRP-funded projects completed 2002-2009 are available at *http://minerals.usgs.gov/about/history.html* (USGS projects) and *http://minerals.usgs.gov/mrerp/reports.html* (projects conducted outside the USGS, funded by the Mineral Resources External Research Program).

2010 Enacted and 2011 Program Performance

Research and Assessments Function
(Estimates for 2009, $36.9 million; 2010, $37.9 million; 2011, $36.8 million)

In 2010, MRP will deliver preliminary results of the first modern national survey of the geochemical components of our Nation's soils. This work involves other Federal agencies, State geological and soil survey organizations, academic soil scientists and geologists, and counterparts in both Canada and Mexico, providing the first truly continent-wide analysis of the soils of North America. It replaces a more than 30-year-old soil survey that included only 1,323 samples for the lower 48 states. The results of collecting and analyzing approximately 5,000 (including Alaska) new samples will enable planners, land managers, and remediation specialists to establish scientifically credible goals for remediation of damaged lands, provide a basis of comparison for any soil analysis that might cause concern, and provide a baseline against which future generations can measure changes in the health of the Nation's soils.

Also in 2010, MRP will deliver three additional multi-year bodies of work (systematic analyses), providing the Nation's decision-makers with information required to understand the context for actions affecting current and future supplies of nonfuel mineral commodities, continue three research and development projects, begun in 2007, providing tools required for the planned 2012 start for updating the 1995 National Mineral Resource Assessment, and undertake new, customer driven mineral resource studies in support of economic development and land management in rural Alaska.

Proposed work for 2011 includes:

- Complete and deliver three major multi-year bodies of work (systematic analyses), providing the Nation's decision-makers with information required to understand the context for actions affecting current and future supplies of nonfuel mineral commodities;
- Continue three research and development projects, begun in 2007, providing tools required for the planned 2013 start for updating the 1995 National Mineral Resource assessment;
- Continue customer-driven mineral resource studies in support of economic development and land management in rural Alaska;
- Continue research on formation processes of deposits that host rare and scarce metals required for emerging technologies;
- Continue environmental geochemical research on processes that occur at sites of mined and unmined mineral deposits;
- Conduct regional-scale geologic data compilation, leading to a new State geologic map for Alaska, scheduled for delivery in 2012;
- Support geochemical, geophysical, and geographic information laboratories required to conduct MRP science and information projects;
- Manage four national-scale long term databases; and
- Provide six formal workshops or training to customers on topics such as understanding the utility of geoscience data for land planning.

In 2011, the MRP will deliver the results of a nine year cooperative project providing the first-ever assessment of global potential for undiscovered deposits of copper, potash, and platinum-group metals, commodities essential to infrastructure, food security, and environmental health. Never before have decision-makers, scientists, and exploration companies had access to a publicly available, consistent global assessment of this type.

Also in 2011, the MRP will deliver results of a multi-year project investigating the geologic factors that influence the occurrence and availability of scarce minerals required for emerging technologies, including alternative energy. Priorities for these studies were established using the results of the National Academy study on critical minerals (published in 2008) and annual stakeholder meetings. Products will provide data and information to underpin both upcoming USGS assessments and decisions by Interior and other land managers.

The Mineral Resources Data System is a worldwide database of metallic and industrial mineral sites with related geologic, commodity, and deposit information. It currently contains information describing about 115,000 locations; new records are continually being added and existing records updated or upgraded. About 200 data fields are available for each location, permitting storage of information on location, geology, description of deposit, exploration and development, description of workings, commodities present, production, reserves and resources, and published and unpublished references. These data are used by planners, land managers, exploration companies, and the public as a means of learning about known mineral deposits, those that are currently being mined and historic sites. The data are available on CD-ROM and as part of the MRP's data delivery web site *(http://mrdata.usgs.gov/)*.

Developing and upgrading national databases, as well as converting those databases to standard formats, is an ongoing effort and will continue in 2011. Enhanced online data delivery tools provide information in digital format to any customer with Internet access; land-management agencies and regional-planning groups report that this direct access to authoritative geologic, geochemical, geophysical, and mineral deposits data is particularly helpful when priorities change and information for new areas is required quickly. The system is available at *http://mrdata.usgs.gov/.*

Data and conclusions from the USGS minerals research will continue to be available to users in easily accessible, accurate, and timely products in 2011. Information is disseminated through traditional paper products, in digital form, on the Internet *(http://minerals.usgs.gov/)*, through interagency collaborations, and in technical and non-technical public presentations. Other methods through which MRP projects provide timely results for all customers include development of new geophysical and geochemical techniques for mineral-resource studies and the application of mineral-resource expertise and techniques to other societally relevant issues such as mapping earthquake and volcanic hazards, location and evaluation of energy resources, characterization of hydrology, or location of buried ordnance.

In 2011 research related to biofuels will focus on the glaciated region of the northern midcontinent to identify soil carbon impacts along a land-use gradient reaching from native grasslands to cultivated areas. Biofuel production may bring significant changes to soil properties in these areas. Changes in soil erosion rate, soil carbon balance, microbiology, and soil nutrient geochemistry are among the probable consequences of biofuel production. The soil carbon balance is an important parameter in assessing the net atmospheric carbon gain or loss from biofuel production. These studies will utilize soil carbon dioxide (CO_2) flux measurements, stable carbon isotope data, and soil microbial studies to determine controls on soil carbon gains and losses. The microbiological studies will utilize a newly acquired equipment to track abundance and types of soil microbes. The studies will document combined impacts of land use and climate change on soil properties, monitor their change over time, and provide a basis for including predictions of the future course of soil development in existing models.

Minerals Information Function

(Estimates for 2009, $15.5 million; 2010, $15.9 million; 2011, $ 15.6 million)

Proposed work for 2011 includes:

- Collect, analyze, and disseminate timely information and data on domestic supply and availability for about 100 mineral commodities, in the United States and 180 other countries;
- Conduct specialized studies of materials flows and recycling of nonfuel minerals throughout the economy; and
- Deliver at least 700 mineral commodity and related reports.

Mineral materials are essential to the U.S. economy and national security. USGS information and data cover the extraction, production, and refining of mineral commodities and some of their products. Interior, the DOD, and the DOS, the Central Intelligence Agency, the Federal Reserve, and private sector companies utilize USGS mineral-related policy analysis in their regional and global analyses. Information on strategic minerals is also provided to the DOD for managing the National Defense Stockpile.

The USGS mineral commodity specialists provide production and capacity data for the U.S. nonfuel minerals industry to the Federal Reserve Board (FRB). The FRB uses data in USGS minerals information reports to calculate the indexes of industrial production, capacity, and capacity utilization, which are among the most widely followed monthly indicators of the U.S. economy. These capacity indexes and the rates of capacity utilization based upon them are published monthly in FRB's G.17 release, Industrial Production and Capacity Utilization. USGS scientists also provide assistance to FRB economists and policymakers in analyzing mineral industry indicators and trends.

Program Performance Overview

End Outcome Goal 2.4: Improve the understanding of Energy and Mineral Resources to Promote Responsible Use and Sustain the Nation's Dynamic Economy.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of energy and mineral resource information and systematic analyses needed by land and resource mangers for informed decision making**										
% of targeted non-fuel mineral commodities for which up-to-date deposit models are available to support decision making **(SP) (MRP)**	C	0%	0%	7%	20%	20%	53%	73%	+20%	93%
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (6/6)	100% (6/6)	100% (3/3)	100% (3/3)	100% (3/3)	100% (4/4)	100% (3/3)	0	100% (3/3)
Efficiency and Other Output Measures										
# of systematic analyses and investigations completed **(BUR) (MRP)**	A	6	6	3	3	3	4	3	-1	3
Total projected cost ($000)		**$25.8M**	**$22.2M**	**$14.1M**	**$14.7M**	**$14.7M**	**$23.6M**	**$30.3M**	**+$6.7M**	**$68.1M**
Average cost per systematic analysis or investigation (whole dollars)		**$4.3M**	**$3.7M**	**$4.7M**	**$4.9M**	**$4.9M**	**$5.9M**	**$10.1M**	**+$4.2M**	**$22.7M**
Comment	Reported cost per systematic analysis is the average of the actual (multi-year) cost of the systematic analyses completed in each fiscal year.									
# of formal workshops or training provided to customers **(BUR) (MRP)**	A	8	7	6	6	6	8	6	-2	6
# of mineral commodity reports available for decisions **(MRP)**	A	690	717	649	700	707	720	700	-20	700

Activity: Geologic Hazards, Resources, and Processes

Subactivity: **Geologic Resource Assessments**
Program Component: **Energy Resources**

	2009 Enacted	2009 Recovery Act [3]	2010 Enacted	2011			Change From 2010 (+/-)
				DOI-Wide Changes [1, 2] (+/-)	Program Changes (+/-)	Budget Request	
Energy Resources ($000)	26,749	0	28,237	-431	3,000	30,806	2, 569
Total FTE	*151*	*0*	*151*	*-2*	*+5*	*154*	*+3*

1) $357 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Energy Resources Program

Request Component	($000)	FTE
• New Energy Frontier - Wind	+3,000	+5
TOTAL Program Changes	**+3,000**	**+5**

Justification of 2011 Program Changes

The 2011 budget request for the Energy Resources Program (ERP) is $30,806,000 and 154 FTE, a program change of +$3,000,000 and +5 FTE from the 2010 Enacted budget.

New Energy Frontier – Wind (+$3,000,000 / 5 FTE)

USGS will study the impacts to wildlife associated with new technologies used for the development of wind energy and work closely with Interior agencies to provide scientific information needed to make informed decisions concerning permitting, implementation and operation of wind facilities on public lands.

USGS research, modeling, and monitoring will evaluate the ecological impacts to fish and wildlife associated with the widespread development of wind energy. Ecological and geographic studies will examine impacts to fish and wildlife from direct strikes, habitat fragmentation, and construction and maintenance of infrastructure. The infrastructure needed for energy capture and transmission would include wind turbines and generating facilities as well as towers, cables, and roads, sea bed corridors, and boat traffic. USGS science will be directed towards studying causes and solutions proposed to minimize risk to fish and wildlife. USGS will assess the ecological impacts of projected large-scale development of wind-farms in the Great Plains and offshore in the Atlantic. In addition, USGS science will provide technical support, establish a comprehensive data management structure, facilitate collaboration, and ensure long-term

viability of information products that contribute to the Nation's understanding of the management and effects of wind energy. In 2011, USGS efforts will begin in the Great Plains and offshore Cape Cod region, and will work toward developing an assessment methodology that can be applied nationwide. These proposed efforts will build on work that is being started in 2010.

Additional information regarding this program change is provided in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

An Overview:
Energy Resources Program

- Conducts research to better understand the processes that lead to the formation and accumulation of energy resources (oil, natural gas, coal, and others such as geothermal and gas hydrates) and the environmental and human health effects of energy resource occurrence and use.
- Uses the results of geoscientific studies to evaluate energy resource accumulation and distribution and to assess the energy resource potential of the Nation and the world (exclusive of U.S. Federal offshore waters).
- ERP conveys results from these studies to land and resource managers and policymakers in support of the Department's goal of improving the understanding and wise use of energy resources.

Program Overview

The Nation faces simultaneous challenges from an increasing need for energy resources, dependence on imported energy resources, and growing demands to minimize environmental effects associated with energy resource development and utilization. Major consumers of ERP products are the Interior's land and resource management bureaus, other land management agencies such as the USFS, Federal environmental and national security agencies, policymakers and other Congressional offices, State geological surveys, the energy industry, the environmental community, the international energy community, academia, and the public.

2010 Enacted and 2011 Program Performance

Energy Policy Act of 2005 Implementation — The Energy Policy Act of 2005 calls for several major activities for which the USGS science is a critical component.

National Geological and Geophysical Data Preservation Program
(Estimates for 2009, $1.0 million; 2010, $1.0 million, 2011, $1.0 million)

Section 351 of the Energy Policy Act of 2005 established the National Geological and Geophysical Data Preservation Program. From 2007 to 2009, program priorities were to support state geological surveys and DOI bureaus to inventory geological and geophysical data collections, create metadata for items in those collections, and provide a means for customers and stakeholders to discover the information through a web-based National Digital Catalog developed with the USGS Geospatial Information Office. In 2010, the Program added two priorities, digital infrastructure and special needs for data at risk.

Data include collections of physical Earth materials (rocks, soils, fluids, minerals, fossils), digital data collected from the Earth (seismic data, chemical data, well log data), and paper maps, charts, and logs.

In 2007, the Program issued a Program Announcement inviting each state geological survey to apply for $5,000 to begin inventorying their collections of geological and geophysical data and entering the information in an on-line collections inventory. Thirty-five state geological surveys

responded and matched USGS funding of $175,000 on a 1:1 basis resulting in $350,000 for states to inventory their collections.

In 2008, the USGS NGGDPP issued a Program Announcement inviting all state geological surveys to submit proposals for funding to continue inventorying collections and to begin creating metadata for items in those collections. The collection inventories and metadata form the National Digital Catalog. The digital catalog will allow users to search for and discover geoscience data held by the states. Thirty-four states submitted proposals requesting $1,067,756 from the USGS. The USGS was able to provide $541,000 which when matched on a 1:1 basis by state funds resulted in $1.082 million for states to inventory and create metadata.

The 2009 USGS NGGDPP Program Announcement invited all state geological surveys to submit proposals to continue inventorying collections and creating metadata. The Program provided $550,000 to fund 29 states. States matched Grants funds 1:1, resulting in nearly $1.1 million to support inventory and metadata work. By the end of 2009, more than 750,000 sample records had been entered in the National Digital Catalog. In 2009, the program co-sponsored a workshop for state participants to promote standardization of metadata formats and provide training to upload metadata records to the National Digital Catalog. The workshop also provided a forum to share best practices for data preservation.

In 2010, NGGDPP priorities continue to be inventorying collections and creating metadata to populate the National Digital Catalog of archived materials. Two priorities added in 2010 are: digital infrastructure, including converting paper documents to digital formats, updating digital formats, and new computer equipment and; special needs awards for data rescue – time-dependent preservation of unique geoscience data or collections in imminent danger of loss from decaying physical surroundings, disposal, or deteriorating media. The Program will award about $550,000 to fund state efforts. Thirty states submitted proposals and the review panel will meet in late January 2010. State geological surveys will provide a 1:1 match for the $550,000 resulting in $1.1million to support inventory, metadata, digital infrastructure, and data rescue work.

Other Energy Policy Act Implementations — The Energy Policy Act of 2005 addresses many energy sources, with an emphasis on assessment of geothermal resources, alternative energy sources such as gas hydrates and oil shale, and research into unconventional gas resources. The Act also reauthorizes the Energy Policy and Conservation Act Amendments of 2000 (EPCA), in which the USGS assesses oil and gas resources underlying Federal lands in the United States.

Energy Independence and Security Act of 2007 Implementation – The Energy Independence and Security Act (EISA) of 2007 calls for the USGS to develop a methodology for a national geologic carbon sequestration assessment and conduct a national assessment using the new methodology. EISA also calls for the USGS to assist BLM in an evaluation of geologic carbon sequestration on public lands.

Geologic Carbon Sequestration Assessment Methodology
(Estimates for 2009, $1.5 million; 2010, $5.0 million, 2011, $5.0million)

The USGS has drafted a methodology to assess the Nation's resources for geologic carbon sequestration in oil and gas reservoirs and saline formations. This methodology has been designed to estimate storage resource potential that can be applied uniformly to geologic formations across the United States. The resource that is assessed is the volume of pore space

into which CO_2 can be injected and retained. The methodology uses probabilistic methods and statistical evaluation to identify the range of possible storage resources within a storage assessment unit and the probability that some fraction of all the storage sites could retain a minimum storage mass of CO_2. The estimated mass of storage resource is further evaluated with parameters that describe the probability of successful containment of CO_2. Because the physical properties of CO_2 at subsurface pressures and temperatures are similar to the properties of petroleum, the CO_2 resource assessment methods reported are built on the principles of USGS geologic oil and gas resource evaluation and assessment. Oil and gas assessments conducted by the USGS evaluate the technically recoverable, undiscovered resource which is a fraction of the total in-place resource that may be recoverable with technology available at the time of the assessment and for some limited time into the future. Similarly, this assessment methodology for CO_2 storage resources focuses on the technically accessible resource, not a total in-place resource volume. This is a resource that may be available using present day geological and engineering knowledge and technology for CO_2 injection into geologic formations. No economic factors are used in the estimation of the volume of resource.

The methodology was made available for comment by the public and, as with all ERP assessment methodologies, an independent panel was convened with expertise in these issues composed of appropriate representatives from Federal agencies, academia, nongovernmental organizations, State organizations, industry, and the international geoscience community to review the methodology. Upon completion of the review the methodology will be published.

Application of the new geological sequestration assessment methodology to evaluate the Nation’s potential resource of geological storage will begin in 2010 after revision of the methodology.

National Oil and Gas Resources

(Estimates for 2009, $15.0 million; 2010, $15.0 million; 2011 $15.0 million)

> “ The most widely respected source of information on global conventional oil and gas resources is the U.S. Geological Survey.”
>
> International Energy Agency
> World Energy Outlook 2009
> page 394.

The Nation's future petroleum energy supplies will likely come from a mix of domestic oil and gas fields, from oil and gas imports, and potentially from unconventional resources such as natural gas hydrates. The concern about greenhouse gas emissions, recent legislation such as Energy Policy Act of 2005 and EISA of 2007, and concern about fuel prices and energy security have raised the importance of the effort to identify and characterize the Nation's domestic petroleum resourcest. ERP research continues to focus on areas of the Nation that have high potential for future natural gas production (Figure 1), including coalbed gas; on those areas that have oil and gas resources under public lands; on the scientific challenge of reducing the uncertainty (or “improving the precision”) of petroleum resource assessments; and on studying unconventional resources such as natural gas hydrates and oil shale.

The ERP is estimating the volume of undiscovered oil and gas resources in the United States, including that underlying Federal lands. This scientific inventory of oil and gas resources on Federal lands is mandated by the EPCA (P.L. 106-469 §604) and forms the basis for the periodic report to Congress required by the Act. The EPCA legislation was reauthorized with

the passage of the Energy Policy Act of 2005, P.L. 109-58. The legislation mandates use of USGS estimates of undiscovered oil and gas resources.

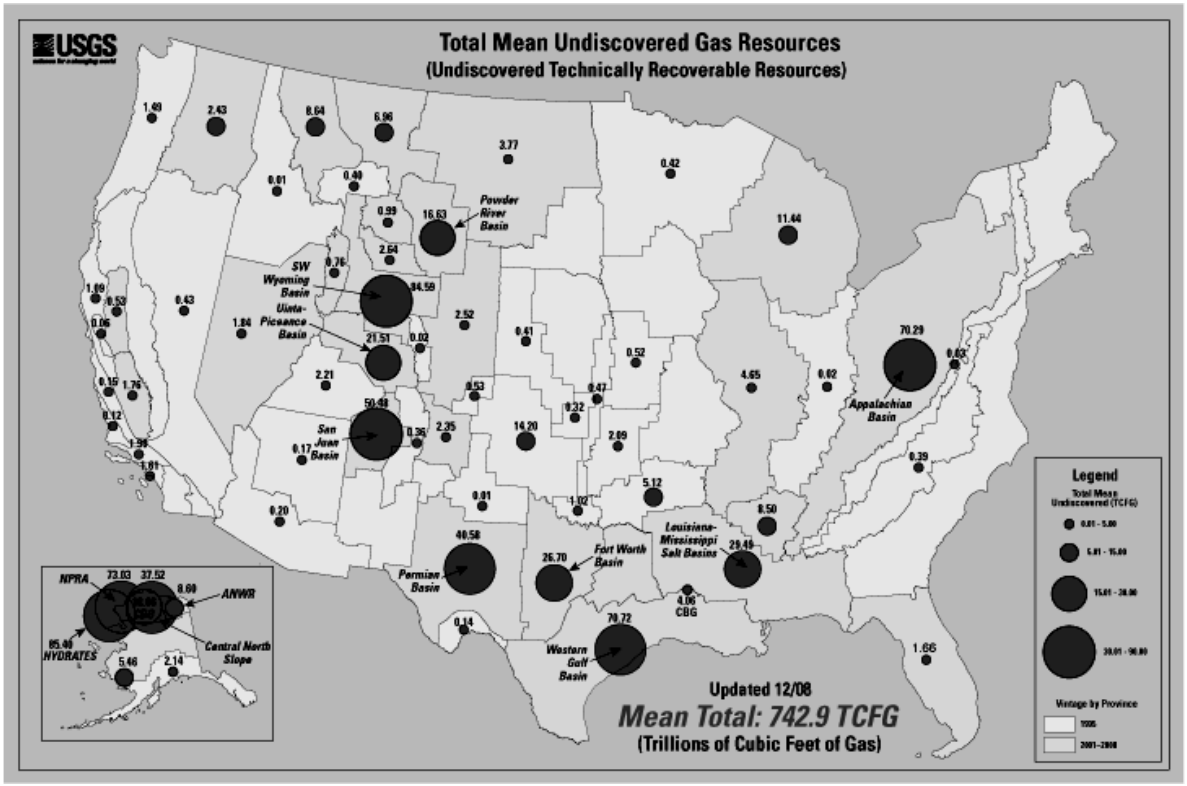


Figure 1. USGS estimates of total, mean, undiscovered, technically recoverable gas resources in the United States (available at *http://certmapper.cr.usgs.gov/data/noga00/natl/graphic/2007/total_gas_mean_07.pdf*)

The USGS will continue to update its oil and gas resource assessments for the United States and the world using a consistent, peer-reviewed methodology as authorized in the Energy Policy Act of 2005 (P.L. 109-58 §364). In 2010 and 2011, the USGS will complete assessments of the Arkoma Basin, the Anadarko Basin, Cook Inlet, and portions of the Gulf Coast.

Alaska — The North Slope of Alaska is thought to have the greatest remaining petroleum resource potential of any U.S. onshore area. The USGS is conducting an intensive examination of Alaska's geology and petroleum potential with current research focused on: synthesizing conventional and nonconventional oil and gas resources information for the entire North Slope of Alaska, including the National Petroleum Reserve Alaska (NPRA), Arctic National Wildlife Refuge (ANWR)-1002 area, the central portion of the North Slope (CNS), and the area west of NPRA.

During 2010, reports summarizing the aggregation of assessment results from ANWR, NPRA, CNS, and the area west of NPRA will be completed and estimates of undiscovered, technically recoverable petroleum resources for the entire northern Alaska province will be finalized. An economic analysis of the entire North Slope was also developed that took into account updated costs and was based on the recently aggregated geologic assessment of the entire North Slope of Alaska. This economic analysis was published in 2009. Field investigations will focus on gas-prone petroleum systems of the Brooks Range foothills, emphasizing research to reduce

assessment uncertainties. Work on the Cook Inlet, an area of high resource potential and importance to Alaska, will continue in 2010.

Gulf Coast Region — The Gulf Coast region is one of the major hydrocarbon-producing areas of the world. As such, the ERP is conducting investigations—using seismic, well, and geochemical data—into the geologic framework of this region. This effort provides the geologic, geophysical, and geochemical framework studies necessary to evaluate the oil-, gas-, and coal-bearing rocks of Texas, Louisiana, Mississippi, and Alabama that have the greatest potential for future oil, gas, and coalbed methane production. A better understanding of petroleum systems will enable USGS scientists to: better assess the potential for undiscovered petroleum resources; and define potential onshore extensions of plays identified by the MMS for offshore Federal resources. Current cooperative efforts with industry, the State Geological Surveys and the MMS will continue to improve data quality and availability. During 2010 and 2011, project staff will conduct research in support of an assessment of the undiscovered petroleum resources of the Jurassic and Cretaceous sections within the Gulf Coast.

Coalbed Methane — USGS geologists are investigating the potential coalbed methane (CBM) resources around the country, including southern Texas and north-central Louisiana, the Powder River Basin (PRB) and Green River Basin (GRB) in Montana and Wyoming, and other areas.

The USGS and the BLM have an ongoing cooperative agreement in the PRB and GRB under which the USGS, in the course of its national geologic studies, produces coal reservoir maps, stratigraphic cross sections, reservoir gas drainage maps, charts of coal reservoir characteristics, graphs of chemical and isotope composition of co-produced water, gas content charts, and estimates of CBM resources. These data and interpretations are used directly by BLM land managers in managing the CBM resources.

CBM gas content, high pressure adsorption (gas or liquid condensing on a surface) isotherms, isotope gas and chemical composition, and indigenous gas-generating microbes in low rank coals have not been well documented in coal basins such as in the PRB, GRB, and Williston basins. Lack of publicly available, reliable, accurate data necessitated the BLM to request theERP to collect new data in advance of development for their resource evaluation and land management work of Federal leases in these basins.

Origin and Controls on Microbial Gas Accumulations — Natural gas generated from microbial activity involving organic deposits (coal, black shale, petroleum) represents an increasingly important natural resource. Until recently, producers tended to ignore microbially derived natural gas deposits because they were considered too small; however the development in the PRB changed that perception. It is estimated that natural gas from microbial activity accounts for about 20 percent of the world's natural gas resource. Since this gas is biologically produced, it also represents a possible renewable resource.

Although a considerable body of research exists on microbial activity, there is much less known about the microbially mediated conversion of materials such as coal to methane. Preliminary studies by the USGS and others have shown that coal gas in many parts of the United States is generated from microbial activity. USGS will continue to conduct field and laboratory studies to better define the processes and organisms involved in microbial production of methane from these materials. In 2010 and 2011, ERP is examining new drilling opportunities to examine factors influencing biogenic CBM production (e.g., geology, coal fracturing, groundwater quality, gas geochemistry), and to obtain new samples of coal, coal gas, coal-associated water, and

endemic microbial populations for laboratory studies. Synthesis of the data and interpretation of pathways of the subbituminous coals of the PRB will augment understanding of the potential to regenerate and sustain the coalbed gas resource in the PRB.

Continuous Resources — Estimates show that the largest remaining undiscovered domestic gas resource occurs in what USGS scientists term "continuous" accumulations, e.g., coalbed methane and basin-centered gas from low-permeability geologic units such as 'tight gas sands' and ‘shale-gas’ reservoirs. (Note: Others use the term 'unconventional' when referring to these resources; however, because these resources can be developed with currently available technology and practices, the USGS employs a narrower definition for unconventional resources, e.g., referring to truly frontier, and currently uneconomic, energy resources such as gas hydrates and oil shale.) Understanding continuous gas resources – the fastest growing resource produced in the United States – is therefore critical, both in terms of the responsible use of this energy resource as well as the sustainability of the domestic energy supply. This work focuses on the identification of the controls on continuous-unconventional gas accumulations, the role of gas–generation processes, and the characteristics of petroleum and associated water. The goal is to develop a sound understanding of the evolution of present-day hydrocarbon accumulations, many of which are currently being produced, but with difficulty, because little is understood about these resources. The mechanisms of the petroleum systems that create and preserve continuous gas accumulations through geologic time are poorly understood for all types of continuous reservoirs. Efforts to reduce these uncertainties will substantially improve the USGS’ ability to conduct future natural gas resource assessments. Research areas that will be emphasized during 2010 and 2011 are: examination of gas-water-oil production; and continued integration of controls on gas preservation.

Reserve Growth — The ERP has an important role in understanding and assessing petroleum resources, both domestically and internationally. Potential additions to reserves from these resources are from the discovery of new accumulations and reserve growth of existing fields. Approximately half of the world's additions to reserves are estimated to come from reserve growth. Because of the significant volumes of petroleum resources involved, the estimation of reserve growth is an integral part of USGS assessments. Because of the importance of reserve growth in accurately estimating resources, the ERP has a research activity focused on establishing procedures to modify new and existing methods and developing a strategy for assessing reserve growth that is peer reviewed before implementation. Reserve growth methods were evaluated by the American Association of Petroleum Geologists (AAPG) Committee on Resource Evaluation (CORE).

Based on the recommendations of the outside peer-panel review, the USGS has revised its methodology to assess reserve growth. The revised methodology will be implemented to provide probabilistic estimates of reserve growth. Activities in 2010 and 2011 will build on the AAPG CORE review, publish the USGS reserve growth methodology, and begin the implementation of that methodology toward an estimation of reserve growth for selected geologic and geographic regions, focusing first on the U.S. and then World estimates.

Gas Hydrates — Currently, the ERP works closely with the Indian Directorate General of Hydrocarbons (DGH) in an effort to study, characterize, and explore for hydrates off the coast of India. In 2010 and 2011, data from 21 sites offshore India will be published and 3-D seismic data for potential new sites of study will be examined. The ultimate goal will be a second research cruise and gas hydrate production test in Indian waters, hopefully in 2011. The data, syntheses, and analyses from the Indian collaboration will be invaluable in understanding world

class hydrate accumulations and lessons learned will be transferable to U.S. domestic gas hydrate resources.

Recent efforts on the Alaska North Slope (ANS) have focused on research to characterize and assess the recoverability and production characteristics of permafrost-associated natural gas hydrates in the Prudhoe Bay-Kuparuk River area and plan for an extended gas hydrate production test, probably to take place in 2011. The ERP is analyzing and interpreting the drilling results from the DOE/British Petroleum Exploration Alaska (BPXA)/USGS Mount Elbert Gas Hydrate Research Test Well, drilled in 2007, in order to continue to refine our geologic and engineering characterization of regional ANS gas hydrate occurrences and to develop detailed interpretations of the Milne Point Mount Elbert gas hydrate prospect. These data will be used to develop and conduct an extended gas hydrate production test on the ANS with the DOE, BPXA, and other government and industry partners.

In 2009, the ERP completed the first-ever resource estimate of technically recoverable gas hydrates. The assessment of the undiscovered, technically recoverable gas hydrate resources on the ANS (Figure 2) used a geology-based assessment methodology. The USGS estimates that there are about 85 trillion cubic feet of undiscovered, technically recoverable gas resources within gas hydrates in northern Alaska, which accounts for 11.5 percent of the volume of gas within all other undiscovered, technically recoverable gas resources onshore and in the state waters of the United States. The area assessed in northern Alaska extends from the National Petroleum Reserve in Alaska on the west through the Arctic National Wildlife Refuge on the east and from the Brooks Range northward to the state-federal offshore boundary (located three miles north of the coastline). The research project in support of this assessment was a cooperative effort with the BLM and the USGS. In 2010 and 2011, the USGS and BLM will focus on improving our understanding of gas hydrates as an energy resource in general and in northern Alaska, so that gas hydrates can be more effectively regulated and managed as a national resource.

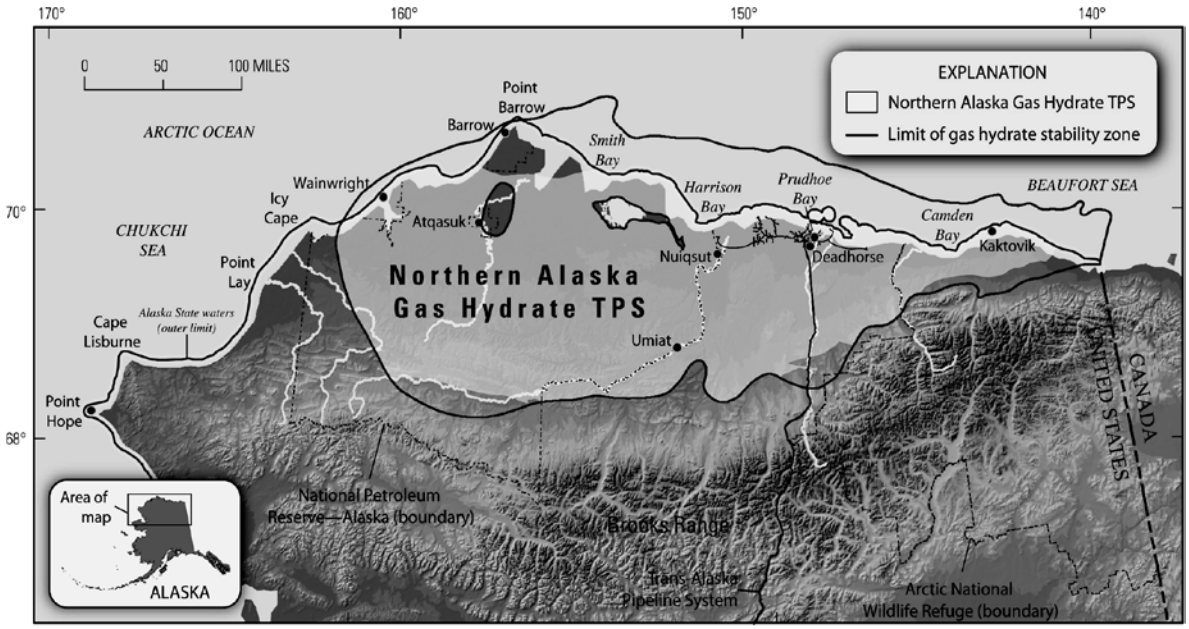


Figure 2. The Northern Alaska Gas Hydrate Total Petroleum System (TPS), and the limit of gas hydrate stability zone in northern Alaska (red outline).

The USGS continues to evaluate the distribution of gas hydrates in the Gulf of Mexico, participating in the Chevron- and DOE-led Joint Industry Project, with drilling and coring in 2009. The very successful research cruise in 2009 led to the characterization of the first offshore area in the United States with enough information to identify gas hydrate energy resource targets with potential for gas production. Another research cruise is planned for 2011, to identify potential targets for production tests.

Oil Shale Resources – The Energy Policy Act of 2005 (P.L. 109-58 §369) recognized the need for updated information on domestic oil shale resources and USGS produced an oil shale assessment of the Green River Formation, Piceance Basin, in 2009. This new assessment included an evaluation of the presence or absence of minerals such nahcolite. Nahcolite is a valuable mineral resource that is presently mined at other locations, but the presence of nahcolite in oil shale can affect the generation and extraction of oil from oil shale, as it decomposes and produces CO_2 when heated. Efforts are also underway to finalize the assessment of other Green River Formation oil shales in the Uinta and Green River Basins, results of which will be published in 2010. Efforts are also underway to study and assess Devonian oil shales located east of the Mississippi River, as mandated in the Act.

One important goal of the oil shale work is to make available on-line as much of the oil shale data from previous studies as possible, including geochemical (Fischer assay, a test for determining the oil yield from oil shale) data, scans of geophysical logs, core and rock descriptions, previous USGS assessments, and other publications. In addition, all USGS publications related to oil shale are now available online through the ERP web site.

Geothermal Resources

(Estimates for 2009, $0.5 million; 2010, $1.5 million; 2011 $1.5 million)

Geothermal Resources — At the end of 2008, in support of the Energy Policy Act of 2005 (P.L. 109-58 §226), the USGS finished a three year project to produce a new national assessment of geothermal resources capable of producing electric power. This new research and assessment work is critical to understanding of geothermal systems (Figure 3) and to determine the extent to which geothermal resources can play a part in the domestic energy mix. The results of this assessment indicate that full development of the conventional, identified systems alone could expand geothermal power production by approximately 6,500 Megawatt Electric (MWe), or about 260 percent of the currently installed geothermal total of more than 2500 MWe. The resource estimate for unconventional Enhanced Geothermal Systems (EGS) is more than an order of magnitude larger than the combined estimates for both identified and undiscovered conventional geothermal resources and, if successfully developed, could provide an installed geothermal electric power generation capacity equivalent to about half of the currently installed electric power generating capacity in the United States.

Subsequent work will highlight geothermal energy resources located on public lands, particularly working in conjunction with BLM and USFS. With a focus on efforts related to renewable energies, additional funding for geothermal activities will support studies to increase our detailed understanding of this underutilized, but potentially important resource. In order to augment the results of the national assessment, studies will be undertaken to more fully understand the nature of geothermal systems and to better improve the viability of this important resource to contribute to the domestic energy mix. The work activities in 2010 include:

<u>Life Cycle Models for Geothermal Systems</u> – A critical issue in evaluating the nature and extent of geothermal resources is developing an improved understanding of the formation and

evolution of the permeable faults and fractures that form most geothermal reservoirs. Characterizing and quantifying the interrelationships among the various geologic and geochemical parameters and effects on fluid and heat transport is critical to understanding what creates and maintains fracture permeability. Research will be devoted to the acquisition and analysis of data on the nature and evolution of geothermal systems in diverse environments. These studies will support the development of an improved geothermal resource assessment methodology relating geospatial observations to accurate predictions of the spatial and temporal frequency and distribution of geothermal reservoirs.

Unconventional Geothermal Resources - There are several unconventional geothermal resources that have potential for electrical generation, the most promising being Enhanced Geothermal Systems. EGS are geothermal resources that require some form of engineering to develop the permeability necessary for the circulation of hot water or steam and the recovery of heat for electrical power generation. The provisional evaluation of EGS in the new USGS assessment indicates that the electric power production potential from EGS is substantially larger than that from all conventional geothermal resources. Yet, significant questions remain regarding EGS development, and new research studies, in coordination with DOE, will be directed at understanding the geologic and hydrologic aspects of EGS development and providing a framework for future assessments of EGS resource potential, including deep sedimentary basin environments.

Online Databases and GIS Products – As part of the resource assessment effort, supporting geological, geophysical, geochemical, and hydrologic data are being combined into databases and GIS maps for analysis. To provide detailed data to complement the assessment, to develop a solid foundation for future assessments, and to maintain comprehensive information on geothermal energy resources and development, these regional and system-specific databases will be placed online and updated on a regular basis. Availability of these types of data will also support the activities of local and national land and resource managers. The majority of geothermal resources in the United States are on public lands and the importance of data cannot be underestimated for responsible management of public resources.

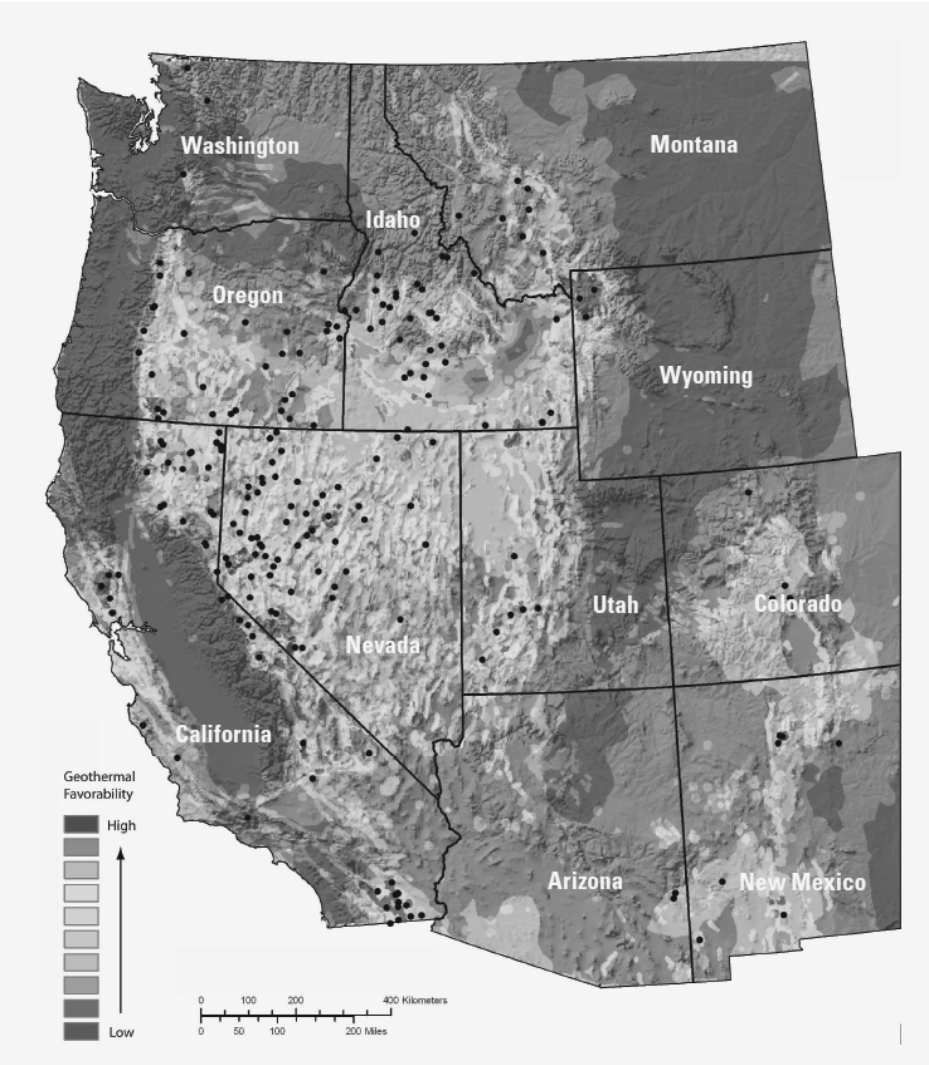


Figure 3. Example map from one of a series of 28 spatial models showing the relative favorability of occurrence for geothermal resources in the western contiguous United States. Identified geothermal systems are represented by black dots.

In 2010 and 2011, research will focus on regional studies to augment the resolution of the national assessment. The primary objectives of which will be to collect, analyze, and interpret those regional datasets that supplement a resource assessment; and to support development of a conceptual model that ties observations of particular parameters (e.g., thermal state of the crust, variations in basin depths) to the physical and tectonic processes (e.g., active extension, magmatic intrusions, fault interactions) responsible for the formation of geothermal systems.

National Coal Resources

(Estimates for 2009, $1.4 million: 2010, $1.4 million; 2011 $1.4 million)

Previous ERP coal resource assessments evaluated the total in-ground coal resource. The ERP has recently revised the USGS assessment methodology to determine the subset of U.S. coal resources that is both available for mining and technically recoverable (i.e., the coal reserve base). In 2009, ERP published the revised assessment for the Gillette Coal Field, the largest coal field within the PRB. Work on the entire PRB will continue throughout 2010 and

analysis of other basins will begin in 2011 using this new approach, with a focus on coal-bearing basins of the Colorado Plateau. These new studies will illustrate how much resource is actually available and technically recoverable.

Federal and State land managers use these results to support land-use decisions; environmental regulators use the information to evaluate compliance with regulations stemming from the 1990 Amendments to the Clean Air Act; and economists use the results to forecast economic trends at regional and national scales. Electric utilities, coal producers, and coal consumers also use these results and products for evaluating the availability and quality of coal feedstock to electricity generating power plants and to achieve compliance with emission standards and other environmental regulations. The ERP is working closely with counterparts at other organizations (BLM, the Energy Information Administration) to ensure that the revised products address a variety of needs.

The need for such a reserve evaluation of the U.S. coal endowment was emphasized in a recent National Academies of Science study "*Coal: Research and Development to Support National Energy Policy"* (2007). That study recognized the importance of coal to the U.S. economy and that Federal policy makers require accurate and complete estimates of national coal reserves to formulate coherent national energy policies. The study also validated the USGS role in such an effort by recommending that the USGS lead a Federal-State-industry initiative to quantify and characterize the Nation's coal reserve base.

World Oil and Gas Resources

(Estimates for 2009, $2.3 million; 2010, $2.3 million; 2011 $2.0 million**)**

The USGS World Petroleum Assessment Project conducts geologic studies that improve the understanding of the quantity, quality, and geologic distribution of world oil and gas resources.

In 2008 USGS released the first products of the Circum-Arctic Resource Appraisal (CARA) This assessment of undiscovered conventional oil and gas resources covered all areas north of the Arctic Circle, and is the only publicly available resource estimate of the entire Circum-Arctic. Using a geology-based probabilistic methodology, the USGS estimated the occurrence of undiscovered oil and gas in all geologic provinces thought to be prospective for petroleum. The sum of the mean estimates for each province indicates that 90 billion barrels of oil, 1,670 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids may remain to be found in the Arctic, of which approximately 84 percent is expected to occur in offshore areas. This work builds on previous ERP world petroleum assessments, which identified the Arctic region as an area of significant petroleum potential. Knowing the potential resources of the Arctic is critical to understanding natural resources and future energy supplies to the United States and the world. The CARA shows that these resources account for about 22 percent of the undiscovered, technically recoverable resources in the world. The Arctic accounts for about 13 percent of the undiscovered oil, 30 percent of the undiscovered natural gas, and 20 percent of the undiscovered natural gas liquids in the world. In addition to the resource assessment, the USGS is conducting a full cycle analysis to put the resource estimates into an economic focus.

In 2009, new and detailed results from the Circum-Arctic Resource Appraisal were published, providing information related to new understandings of the future of petroleum, of the potential for environmental conflicts, and of the primary drivers of international energy politics in the Arctic. Building on a summary of findings released in 2008, the information published in 2009 presents new interpretations, detailed statistical results, and links to Arctic maps and data tables. Because of the recent retreat of Arctic ice and the prospect of intensified energy

resource development, this landmark study is vitally important to the Arctic nations and to all those concerned about the fragile polar environments as well as future energy sources.

Resource cost curves are being developed which will provide an indication of the economic viability of these resources. This full cycle analysis will be finished in 2010. Other analyses and syntheses of the data and results from the CARA will be developed throughout 2010.

Currently, the ERP is prioritizing and re-assessing basins of the world that were included in the USGS 2000 assessment. In addition, the ERP has initiated a screening process for the presence/absence of continuous, resources (heavy oil, tight gas, shale gas, coal-bed gas) in priority basins of the world. This screening process will allow ERP to assess global continuous resources, an effort that no one has ever attempted. This is one of the most requested products from ERP, so world petroleum assessment efforts in 2010 and 2011 will focus on continuous global resources.

Energy Information and the Environment

(Estimates for 2009, $7.0 million; 2010, $7.0 million; 2011 $7.0 million)

ERP scientific studies focused on environmental and human health challenges include characterization of waters co-produced with oil, gas, and coalbed methane, in order to determine best disposal practices, human health impacts of energy resource occurrence and use, and legacy environmental impacts from previous uranium mining.

Coal Quality and Human Health — The ERP conducts research to understand the natural variability of coal quality, and the ramifications of such variability on environmental quality and human health. For example, in many parts of the country and the world, coal deposits may act as natural aquifers and convey large amounts of potable water. Balkan Endemic Nephropathy (BEN), a disease thought to develop from long-term exposure of susceptible individuals to low levels of toxic organic compounds derived from coal in drinking water in many parts of the Balkans, has been extensively studied by the USGS in conjunction with the human health care sector and international doctors. The ERP continues to build on the expertise developed during the BEN study by evaluating linkages in the United States and other countries where the confluence of specific human diseases and toxic organic compounds from coal may occur. In the United States, the water obtained from low-rank coal beds, either by drinking water wells or by coalbed methane production wells, may have leached toxic organic compounds from coal. The ERP is characterizing water quality in these settings. ERP researchers have been contacted by a number of foreign scientists who have noted BEN-like symptoms within their own countries. A number of cooperative efforts have formed from these contacts, leading to an increased understanding of this disease.

Because more than half of the Nation's electric power supply relies on coal as a fuel, and electric power demand will continue to increase in the future, an understanding of the connections among coal quality, environmental quality, and human health during coal resource utilization is essential to resource managers and policymakers alike. The ERP will continue to work with representatives from the human health care sector, Center for Disease Control (CDC), National Institutes of Health (NIH), National Institute of Environmental Health Sciences, and other domestic and international groups of doctors, epidemiologists, and health care providers to investigate health effects that may be associated with energy resource use.

National Coal Resources Data System (NCRDS) – Started more than 25 years ago, USGS databases contain information on the location, quantity, attributes, stratigraphy, and chemical

components of U.S. coal deposits, including quality analyses of more than 14,000 coal samples and some 200,000 stratigraphic records. At least 136 coal-quality parameters are determined, including detailed location information and a wide range of physical and chemical properties. The NCRDS stratigraphic database contains more than 30 parameters describing the geologic section measured from drill holes and surface exposures including specific geo-referenced information. These data are accessible through USGS-constructed interfaces to perform several analytical capabilities and produce a robust suite of products addressing several coal resource assessment issues, including: locating coal deposits having desirable characteristics for various uses; assessing environmental impacts of coal use; evaluating coal resources; and describing technological properties of coal from specific areas and beds. A long-term partnership of the USGS and approximately 22 State geological surveys, both contributors to and users of the databases, has formed the basis of this sustained effort to collect, correlate, and analyze the basic data, build and verify the databases, and digitally utilize these USGS-maintained data sets. Portions of the coal resource and geochemical databases can be found on the USGS Energy Web site *(http://energy.usgs.gov)*, or interested parties may request selected data in several formats.

Produced Waters – Production of oil and gas resources also yields significant quantities of water. Current estimates indicate that about 920 billion gallons of water are produced annually in the U.S. from traditional oil and gas development and production (U.S. DOE, 2006) and an additional 24 billion gallons result from coalbed methane production (Rice and Nuccio, 2000). With increasing interest in energy resource development from such areas as the Marcellus shale gas deposits in the Appalachian Basin and the Bakken oil play in the Williston Basin, produced water and fluids used and recovered during hydrofracturing (hydrofracing) are likely to play an expanding a role in energy resource considerations, because treatment and disposal costs for produced and hydrofracing waters vary markedly between and within basins. Also, beneficial use of produced waters is an area of expanding interest, particularly in areas with limited water resources. However in many cases, the impacts of utilizing produced waters in innovative methods are not well understood. To facilitate scientifically based robust decision making, this ERP effort will provide information on the volume, quality, impacts, and possible uses of water produced during generation of oil, gas, and coalbed natural gas production and development. This information will be disseminated for use in energy resource, regulatory and policy decisions. In 2010 and 2011 this activity will develop and expand a central online clearinghouse for information associated with CBM development across the United States with emphasis on the geochemistry of CBM produced waters; continue collaborative research on the environmental impacts and operational approaches for application CBM waters to crop land in the Powder River Basin using subsurface drip irrigation systems; and investigate the current availability and(or) gaps in the produced water quality data for emerging energy resource development areas within the northern Appalachian Basin.

Uranium – Uranium resources became a significant fuel for use in electric power generation starting in the 1950s, and nuclear energy now accounts for about 20 percent of U.S. generated electricity. Uranium to supply this energy has been mined at about 4100 mine sites in the western states of Wyoming, New Mexico, Colorado, Utah, Arizona, and Texas. Over the past five years, interest in U.S. uranium supplies has grown as demand for nuclear energy has increased and nuclear energy plants are under construction or in various stages of planning. Updated knowledge of the geologic setting, occurrence, and estimates of the magnitude of the undiscovered U.S. uranium resource endowment is critical to inform these planning efforts about the potential for domestic uranium supplies to sustain or increase the contribution of nuclear energy to the U.S. energy mix. The recent resurgence in uranium prices and resulting company activity in the U.S. has also raised visibility of legacy uranium mining impacts, which

are widespread in the western U.S., especially in those areas mined prior to the development of modern environmental regulations. In spite of uranium mill tailings legislation and subsequent cleanup, and reclamation of many uranium mine sites since the late 1970s, a substantial legacy of orphaned uranium mine sites and problems at uranium mill sites remains. Scientific investigations of legacy uranium mining and milling areas and historic and ongoing uranium mining operations are needed to: determine the effects on soils, surface water and ground water of such past operations; provide data relevant to human health and environmental impacts; develop geochemical techniques to discriminate mining impacts from naturally occurring uranium and other trace elements in the environment; develop a better understanding of the processes operating at such sites through reactive transport modeling. USGS scientists will work with the BLM, Bureau of Indian Affairs, NPS, USFS, EPA and state agency geologic, water, resource, and regulatory personnel to identify outstanding uranium mine, mine waste, and mill waste problems on Interior and other lands where USGS capabilities can assist in evaluating mine and mill waste sources, dispersion from sites, and prioritization of reclamation efforts.

In 2010 and 2011 this activity will complete an evaluation on uranium resource availability in the Grand Canyon area as a part of the impacts of a proposed Federal lands withdrawal; begin an investigation with scientists from the MRP into the current understanding of uranium ore deposit models that could be used to underpin a methodology for an updated assessment of undiscovered uranium resource estimates; identify a legacy field site for evaluation of in-situ recovery (in situ leach) effects and conduct sampling for detailed geochemical and mineralogic investigations.

Energy Information – The ERP generates large volumes of science-based research information that requires long term stewardship as well as easy access to support integrated science, meet Federal information mandates, and serve the public. Delivery of ERP information via the internet is a key objective and improvements in that capability are a high priority. The project is developing an integrated, map-based, interactive application through the web portal that replaces and updates a number of older, obsolete applications that are hard to access and difficult to maintain. A prototype has been developed and is operational and is undergoing extended testing with several key geospatial datasets. To improve delivery of geospatial data, the information team works with ERP scientists to design data management systems from the beginning of the investigation with the ultimate goal of optimizing final information delivery. The project also completed extensive evaluation of information delivery needs in order to redesign the ERP website to improve discovery and navigation, serve more information, and reduce maintenance and upgrade burdens. Following a phased design process, implementation of the redesigned website is scheduled for 2010. The project this year will refit some equipment that is approaching capacity to provide more storage and backup capability. Public requests for ERP information related to the Bakken Formation oil resource assessment, which are answered individually, became so great that Frequently Asked Questions (FAQs) and responses were prepared for the USGS bureau website. Since the FAQs were made available in March, 2010, the Bakken FAQs have recorded over 235,000 individual visits, representing approximately 20% of all visits to the USGS FAQ site. ERP also established the rapidly growing USGSENERGY Twitter feed to deliver notification of new publications and other ERP information rapidly.

Program Performance Overview

End Outcome Goal 2.4: Improve the understanding of Energy and Mineral Resources to Promote Responsible Use and Sustain the Nation's Dynamic Economy.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of energy and mineral resource information and systematic analyses needed by land and resource mangers for informed decision making**										
# of targeted basins/areas with energy resource assessments available to support management decisions **(SP) (ERP)**	A	6	5	5	5	6	5	5	0	5
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure the quality and relevance of science information and data to support decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (5/5)	100% (5/5)	100% (5/5)	100% (5/5)	100% (6/6)	100% (5/5)	100% (5/5)	0	100% (6/6)
Efficiency and Other Output Measures										
# of gigabytes collected annually **(BUR) (ERP)**	A	158.048	37.409	1.173	3.1189	17.6482	1.240	3.4090	+2.169	3.4295
# of metadata records **(BUR) (Data Preservation)**	C	UNK	UNK	UNK	Measure being baselined in 2009	600,000	600,000	TBD	--	TBD
# of systematic analyses and investigations completed **(BUR) (ERP)**	A	5	5	5	5	6	5	5	0	6
Total projected cost ($000)		**9,900**	**7,800**	**13,750**	**13,750**	**13,750**	**13,750**	**13,750**	**0**	**13,750**
Actual projected cost per analysis (whole dollars)		**$1.98M**	**$1.3M**	**$2.75M**	**$2.46M**	**$2.75M**	**$2.75M**	**$2.75M**	**0**	**$2.75M**
# of outreach activities provided to customers **(BUR) (ERP)**	A	8	8	8	8	8	9	10	+1	10

Water Resources Investigations

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Hydrologic Monitoring, Assessments, and Research ($000)	150,786	14,625	160,246	-4,590	+3,074	158,730	-1,516
FTE	*882*	*0*	*879*	-15	*+5*	*869*	*-10*
Cooperative Water Program ($000)	64,078	0	65,561	-1,963	*0*	63,598	-1,963
FTE	*679*	*0*	*676*	*-20*	*0*	*656*	*-20*
Water Resources Research Act Program ($000)	6,500	0	6,500	-1	0	6,499	-1
FTE	*2*	*0*	*2*	*0*	*0*	*2*	*0*
Total Requirements ($000)	**221,364**	**14,625**	**232,307**	**-6,554**	**3,074**	**228,827**	**-3,480**
Total FTE	***1,563***	***0***	***1,557***	**-35**	***+5***	***1,527***	***-30***

1) $3,266 in fixed costs is absorbed ($2,132 in Hydrologic Monitoring, Assessments and Research, $1,134 in Cooperative Water Program, and $0 Water Resources Research Act Program)

2) See the General Statement and Section G for Details on DOI-wide Changes.

3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Activity Summary

The 2011 budget request for the Water Resources Investigations Activity is $228,827,000 and 1,527 FTE, a net program change of +$3,074,000 and +5 FTE from the 2010 enacted level. Additional information on program changes is provided in each subactivity section and in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

Since 1879, the USGS has been involved in issues related to water availability, water quality, drought and flood hazards. This legacy continues through the efforts of hydrologic professionals and support staff located in all 50 States and Puerto Rico. As the primary Federal science agency for water information, the USGS monitors and assesses the amount (quantity) and characteristics (quality) of the Nation's freshwater resources, assesses the sources and behavior of contaminants in the water environment, and develops tools to improve the management and understanding of water resources. The information and tools allow the public, water managers and planners, and policymakers to:

- Minimize loss of life and property as a result of water-related natural hazards, such as floods, droughts, and land surface movement;
- Effectively manage freshwaters, both above and below the land surface, for domestic, public, agricultural, commercial, industrial, recreational, and ecological uses;
- Protect and enhance water resources for human health, aquatic health, and environmental quality; and
- Contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations.

Fundamental to USGS water science is the collection and public dissemination of data describing the quantity and quality of the Nation's freshwater resources. During the past 120 years, the USGS has collected streamflow data at over 21,000 sites, water-level data at over

1,000,000 wells, and chemical data at over 338,000 surface-water (streams, rivers, natural lakes, and man-made reservoirs) and groundwater (water beneath the land surface) sites. These data are available online through the National Water Information System (NWIS) at *http://waterdata.usgs.gov/nwis.*

The water resources research, information, and monitoring activities currently underway in Water Resources Investigations programs support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of Water Resources scientists also support USGS Science Strategy themes of understanding ecosystems and predicting ecosystem change, providing a scientific foundation for energy and mineral resources for America's future, climate variability and change, a national hazards, risk, and resilience assessment program, and the role of the environment and wildlife in human health.

> "USGS has unique expertise in analyzing water use, modeling future water needs, and quantifying the linkages between hydrology and ecosystem health. One of the critical needs in better managing our water resources to avoid future conflicts is giving information on water availability and both human and environmental water needs to water managers."
>
> The Nature Conservancy, 2009

Program Reviews

To ensure that USGS programs are meeting the water science and information needs of the Nation, the USGS commissioned the National Academy of Sciences (NAS) to conduct the first independent and holistic review of USGS Water Resources Discipline (WRD) programs. In 2006, the NAS National Research Council (NRC) formed a Committee on Water Resources Activities at the USGS. The Committee looked at a wide variety of data collection and dissemination, hydrologic investigations and analysis activities, as well as basic and applied hydrologic research. The purpose of the review was to assess the water program and recommend how the USGS could best address the Nation's priority water issues. Such reviews in the past have yielded a strong endorsement of the USGS mission and provided useful insights to guide future program development. The NRC assembled a panel of water resources experts from government, academia, and nongovernmental organizations. The Committee met with a wide range of USGS managers, scientists, and customers to obtain a full range of insights into our current program. Many of the Committee's recommendations were directed toward the water resources role in the USGS Science Strategy and national water priorities. In its conclusion, the Committee stated that the USGS "stand(s) on a long tradition of studying the impact of human activities on water resources and ecosystems. Whether society can manage water resources sustainably in light of the growing interdisciplinary issues such as population growth, wealth production, ecosystem needs, and climatic uncertainty, has become the signature environmental issue of our age. The USGS WRD is well suited to play a critical leadership role in a national strategy for water resource management." The final report, "Toward a Sustainable and Secure Water Future: A Leadership Role for the U.S. Geological Survey" was published in 2009 and can be viewed online at *http://books.nap.edu/openbook.php?record_id=12672&page=1*.

During 2009, the USGS embarked on a value engineering study of selected USGS surface water, groundwater, and water-quality data collection procedures. Although the USGS works diligently to continuously improve the quality, efficiency, and cost-effectiveness of its field and office procedures, the USGS took advantage of the opportunity to partner with independent private-sector firms with the necessary experience and expertise to conduct a formal value

engineering study. The purpose of the study was to identify new procedures, instrumentation, and computer software that can improve the efficiency of the USGS data program while maintaining USGS high data quality standards. The first phase of the study focusing on USGS real-time water-quality monitoring was completed in the fall of 2009 and provided useful recommendations that the USGS is working to implement including improving the compatibility of data acquisition and data processing software to enhance the efficiency and cost-effectiveness of water-quality data processing. A study of streamflow measurement and data acquisition procedures is currently underway, and a study of groundwater procedures will follow in 2010. These studies are an example of the USGS commitment to use state-of-the-art methods to provide high-quality hydrologic information in the most cost effective means possible to the Nation's water resources community.

The USGS also has plans underway to have the NRC review the new 10-year plan for the National Water-Quality Assessment (NAWQA) Program, 2013-2023, including recommendations on improvements to NAWQA's design and implementation to address the water-quality issues of the 21st Century. This review is scheduled to be completed in 2011.

The Office of Water Quality, Office of Groundwater, and Office of Surface Water, which are collectively supported by all USGS Water programs, provide technical support, training, and quality assurance for USGS Water programs and Water Science Centers. The activities of these technical offices provide high-level science support and the technology transfer required to maintain scientific excellence. In addition, the technical offices provide an important quality assurance function that is independent from Water Science Center and programmatic management. The offices collaborate to assemble multidisciplinary teams to conduct scientific technical reviews of Water Science Center (WSC) activities within the Water Resources programs of the USGS. These triennial reviews are supported by the work of Water Discipline Technical Specialists in each of the three USGS Regional Offices who work with Water Science Centers to review project proposals, conduct on-site training, and provide technical advice and consultation to USGS field based scientists. The work of these Regional Technical Specialists helps ensure that data collected in USGS field offices are derived from nationally consistent methodologies and of sufficient quality to be included in USGS national hydrologic data bases, that field scientists apply the latest hydrologic techniques, and that new methodologies developed in the field are transferred for use by other USGS offices. The Regional Technical Specialists serve as the principal link between USGS Headquarters, Technical Offices, the National Research Program, and Water Science Center scientists.

Subactivity Overview

Water Resources Investigations comprises three subactivities that operate with three distinctly different funding mechanisms:

The **Hydrologic Monitoring, Assessments, and Research subactivity** includes six programs funded directly from Federal appropriations and conducts work primarily in-house, using the expertise of USGS scientists. The programs in this subactivity include: Groundwater Resources (GWRP), NAWQA, Toxic Substances Hydrology, Hydrologic Research and Development, National Streamflow Information Program (NSIP), and Hydrologic Networks and Analysis (HNA). These programs are oriented toward research and assessment. In addition, NSIP and portions of HNA focus on long-term data collection and NAWQA provides status and trends information on water-quality conditions across the Nation. The **Cooperative Water Program subactivity** provides information needed to understand the Nation's water resources through a program of shared efforts and funding with State, local, municipal, and Tribal

agencies. Authorizing legislation requires that partnering States and localities pay at least half the cost of the work that the USGS performs under this subactivity. The program effectively leverages Federal appropriations and develops program priorities in concert with partners to respond to both local and national needs. About half of program funding supports basic data collection, including 65 percent of the USGS streamgaging network, while the remaining half supports interpretive investigations which address water resources issues at the local, regional, and national level. In recent years, non-Federal partners have increasingly supported a larger share of the program than is called for in the authorizing legislation; however, as State and local budgets become more constrained, it is unlikely that this level of State and local funding can be sustained.

Through the **Water Resources Research Act Program subactivity,** the USGS administers grants for 54 State research institutes designated by the Water Resources Research Act of 1984, as amended by the Water Resources Research Act Amendments of 2006 (Public Law 109-471). The program supports academic research to aid in the resolution of State and regional water problems, promotes technology transfer, and provides for the training of scientists and engineers. Grants under this program must be matched by the receiving universities.

Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program Component: **Groundwater Resources Program**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Groundwater Resources Program ($000)	9,008	0	9,714	-236	-380	9,098	-616
Total FTE	*54*	*0*	*53*	*-1*	*0*	*52*	*-1*

1) $83 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Groundwater Resources Program

Request Component	($000)	FTE
• USGS WaterSMART Availability and Use Assessment	+1,100	0
• Unrequested Congressional Increases	-1,480	0
TOTAL Program Changes	**-380**	**0**

Justification of 2011 Program Changes

The 2011 budget request for the Groundwater Resources Program (GWRP) is $9,098,000 and 52 FTE, a program change of -$380,000 and 0 FTE from the 2010 Enacted level.

USGS WaterSMART Availability and Use Assessment (+$1,100,000/0 FTE)

Currently, the GWRP is conducting large-scale multidisciplinary regional studies of groundwater availability. The purpose of these studies is to quantify current groundwater resources, evaluate how those resources have changed over time, and provide tools to forecast system responses to stresses from future human and environmental uses. The USGS WaterSMART Availability and Use Assessment will require the results derived from these regional groundwater availability studies of the Nation's regionally extensive aquifers or aquifer systems as part of a comprehensive national water availability assessment. The additional resources provided through this initiative will enable the GWRP to embark on one additional study each year, doubling its effort to document the effects of human activities and climate variability and change on groundwater levels, depletions, change in storage, and interactions with surface water resources. A subsequent effort will also begin to develop and demonstrate methodologies for a preliminary national assessment and mapping of brackish and saline groundwater resources.

Unrequested Congressional Actions (-$1,480,000 / 0 FTE)

This reduction will end three unrequested congressional actions. These projects are not Administration priorities and do not address the highest priority Water Resources science needs. This reduction will allow the core Program to remain intact while allowing the USGS to make the best use of available resources. The specific projects are San Diego Aquifer Mapping (-$900,000), Arkansas Sparta Aquifer Recovery Initiative (-$300,000), and the McHenry County, IL Groundwater and Stormwater Project (-$280,000).

Program Overview

Groundwater is one of the Nation's most important natural resources and is becoming increasingly important to all our lives. Groundwater is the primary source of drinking water to approximately half the Nation's population, provides about 40 percent of the irrigation water necessary for the Nation's agriculture, sustains the flow of most streams and rivers, and helps maintain a variety of aquatic ecosystems. The continued availability of groundwater is essential for current and future populations and the economic health of our Nation.

The GWRP provides objective scientific information and interdisciplinary understanding necessary to assess and quantify the availability and sustainability of the Nation’s groundwater resources. The results of those efforts provide foundational information used in decisionmaking by resources managers, regulators, other government agencies, and individuals in the public and private sectors. The goals of the program are to:

- Provide fundamental information about groundwater availability in the Nation's major aquifer systems;
- Characterize the natural and human factors that control recharge, storage, and discharge in the Nation's major aquifer systems, and improve understanding of these processes;
- Develop and test new tools and field methods for analyzing groundwater flow systems and their interactions with surface water; and
- Provide scientific leadership across all USGS programs on matters pertaining to the Nation's groundwater resources, including research directions, quality control, technology transfer, and information storage and delivery.

The program coordinates with and complements a range of other USGS programs by providing new methods, tools, and information used in monitoring, assessment, and resource management activities. The goals of the GWRP directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of GWRP scientists also support USGS Science Strategy themes of climate variability and change, understanding ecosystems and predicting ecosystem change, and a National hazards, risk, and resilience assessment program. In composite, these activities are used to rate performance measures shown in the table at the end of this section.

More information about the Groundwater Resources Program is available on the Internet at *http://water.usgs.gov/ogw/gwrp/.*

2011 Program Performance

To address Program goals, the following activities are planned for 2011:

National and Regional Groundwater Evaluations
(Estimates for 2009, $3.3 million; 2010, $2.3 million; 2011, $3.4 million)

The depletion of groundwater at a variety of scales and the compounding effects of recent droughts emphasize the need for an updated status on the availability of the Nation's groundwater resources. Assessments of the current state of the highest stressed groundwater flow systems are necessary tools for characterizing the availability of groundwater.

The GWRP is taking advantage of the quantitative work previously conducted by the Regional Aquifer-System Analysis (RASA) Program and information available from other USGS programs, other Federal agencies, States, Tribes, and local governments to provide an updated quantitative assessment of groundwater availability in areas of critical importance. Those assessments that are currently underway and will continue into 2011 will:

- Document the effects of human activities on water levels, groundwater storage and discharge to streams and other surface-water bodies;
- Explore climate variability impacts on the regional water budget;
- Provide tools to forecast impacts on groundwater resources from future human and environmental uses; and
- Evaluate the adequacy of data networks to assess impacts at a regional scale.

There is growing recognition by water managers and municipalities of many fundamental advantages of managing groundwater resources on a regional, aquifer-wide scale. They are exploring ways to better manage known groundwater resources while also identifying supplemental sources of water. Upon completion, these multidisciplinary studies of regional groundwater availability across the United States will provide resource managers and policymakers with essential information needed for managing limited water resources in areas experiencing chronic water-supply issues and concerns. As such, results from these studies are requisite for a comprehensive water availability assessment of the Nation. The GWRP is the principal entity within the USGS for assessing the availability of groundwater resources of the Nation's most important regional aquifers. Studies consist of individual assessments of regional groundwater flow systems that cover a variety of hydrogeologic terrains and are used to develop a comprehensive regional and national perspective. Collectively, these individual studies form the foundation for a national assessment of groundwater availability. Availability studies, conducted in cooperation with other Federal, State, and local governments and the private sector, involve computer-based groundwater flow models to document effects of human activities and climate variability on groundwater levels, depletion, storage, and interactions with surface water.

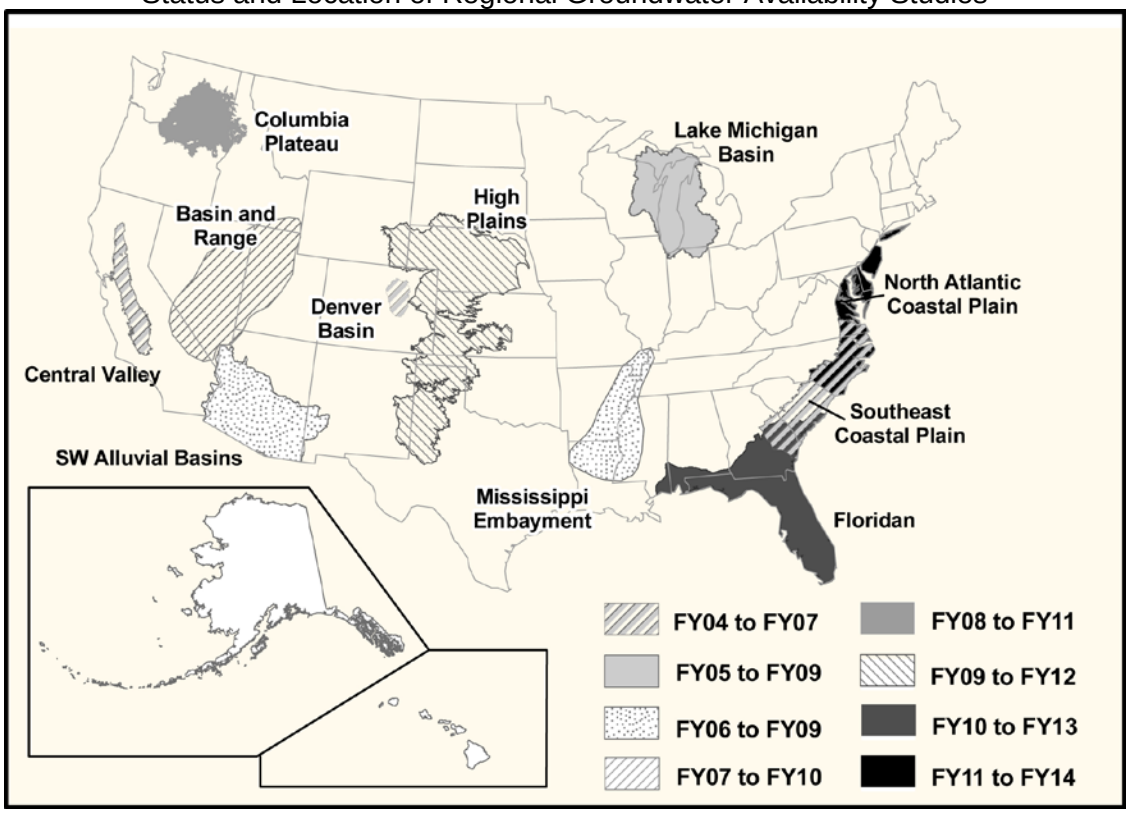
One of the first studies was completed in California's Central Valley, helping resource agencies to assess, understand, and address many issues affecting the joint use of surface- and groundwater supplies, known as

"This new model not only details the current scarcity of groundwater, but also provides a scientific tool to help water managers remedy the situation in the future. " "Science can be invaluable in helping to provide solutions."
Secretary of the Interior Ken Salazar

"conjunctive use." (*http://pubs.usgs.gov/pp/1766/*). Findings showed that groundwater levels are declining in parts of San Joaquin Valley as more water is pumped than is recharged naturally. As part of the assessment, a three-dimensional hydrologic modeling tool is used to simulate water management scenarios to predict possible future changes in water supplies, providing managers improved ability to plan water supplies around anticipated conversion of farmland to urban use and potential future effects of climate variability and change. California's Central Valley assessment is one of more than 30 regional aquifer studies to be conducted that collectively will lead to a national assessment of the Nation's groundwater availability. The approach to a national assessment of groundwater availability is described in Circular 1323 (*http://pubs.usgs.gov/circ/1323/*) and is a key element of the water census of the United States. The water census is a strategic science direction of the USGS, as well as part of the proposed Federal science strategy to meet nationwide water challenges by the National Science and Technology Council (2007) Subcommittee on Water Availability and Quality.

In 2011, the regional groundwater availability study in the Columbia Plateau basin-fill and basaltic-rock aquifers (Washington, Oregon, and Idaho) will be completed. At the same time, regional groundwater evaluation studies focused on the High Plains aquifer, the Floridan aquifer system, and the initial year of the Northern Atlantic Coastal Plain aquifer system study will be underway.

Status and Location of Regional Groundwater Availability Studies



Interactions of Groundwater with the Environment

(Estimates for 2009, $3.9 million; 2010, $4.0 million; 2011, $3.7 million)

Over the past decade groundwater issues have evolved in scope and complexity as a result of escalating demands for the resource. USGS scientists address this increasing complexity by targeting a variety of information needs with a multi-faceted approach to understanding groundwater and linkages to humans and the natural environment. To that end, the GWRP will continue activities related to groundwater resource assessment while also recognizing the need to investigate all aspects of groundwater and its interdependence with the environment. The implementation of such an approach will be met through the Program's involvement in the following topical areas.

Field Methods and Model Development

In 2011, the GWRP will continue to search for more efficient methods to evaluate groundwater resources at a variety of scales. The USGS has been at the forefront of devising new analytical techniques to solve practical problems in the study of groundwater resources. Geophysical methods and application research, along with groundwater model development are specialized activities that support and benefit all USGS projects in accomplishing organizational goals.

The USGS conducts research into new and emerging geophysical methods and applications for groundwater investigations. Near-surface geophysical techniques can be used to rapidly and effectively characterize the shallow subsurface and to monitor hydrologic and remediation processes in ways not previously possible with standard technology. Current efforts have been directed towards development of:

- Fiber-optics distributed temperature sensing field applications;
- Rapid seismic subsurface imaging methods;
- Methods for quantitative interpretation of geophysical tomography data; and
- An easy-to-use stepped-frequency electromagnetic tool for subsurface characterization.

In 2011, these techniques will continue to be refined and new efforts will be directed towards quantitative investigations of the spatial and temporal nature of hydrogeologic structures and processes.

The USGS is at the forefront of devising numerical techniques to solve practical problems in the study of groundwater resources. Predictive models are needed to make informed decisions in many emerging areas related to the effects of groundwater development. New models and methods enhance all USGS water programs and provide critical tools and information needed for informed water-resource decisionmaking. State and local governments, as well as groundwater scientists and engineers in the private sector, regularly use USGS models as an integral part of their work. The USGS Modular Groundwater Flow Model (MODFLOW) is the most widely used program in the world for simulating groundwater flow. In 2011, the Groundwater Resources Program will continue to support the enhancement of MODFLOW with updates that help scientists and engineers simulate common features in groundwater systems. New features will be added and the model will be updated to incorporate advancements in our understanding of groundwater hydrology, to respond to changes in user needs, and to take advantage of constantly increasing computing power. Moreover, in 2011, the GWRP will continue to support the application of USGS groundwater models in complex aquifer settings and to examine challenging water-resource management issues such as assessing water

availability, saltwater intrusion, and the effects of groundwater withdrawals on aquatic ecosystems.

Data and Groundwater Level Monitoring

Collection of fundamental groundwater information is critical to assess and quantify the availability of the Nation's groundwater resources. The USGS maintains a database of groundwater data records from about 850,000 wells that have been compiled during the course of groundwater hydrology studies over the past 100 plus years. Wells are measured for a variety of purposes, such as for statewide and regional monitoring of ambient conditions, or for local monitoring of drawdown, aquifer tests, or even earthquake effects on water levels. The GWRP makes these data available for several networks in an easily accessible manner via the Internet *(http://groundwaterwatch.usgs.gov/)*.

- Active groundwater level network *(http://groundwaterwatch.usgs.gov/default.asp)*
- Climate response network *(http://groundwaterwatch.usgs.gov/Net/OGWNetwork.asp?ncd=crn)*
- Real-time groundwater level network *(http://groundwaterwatch.usgs.gov/Net/OGWNetwork.asp?ncd=rtn)*
- Regional (High Plains) aquifer monitoring network *(http://groundwaterwatch.usgs.gov/Net/OGWNetwork.asp?ncd=hpn)*
- Long-term groundwater data network *(http://groundwaterwatch.usgs.gov/Net/OGWNetworkLTN.asp?ncd=ltn&a=1&d=1)*

The Web pages group related wells and data from historic and active well networks, and provide basic statistics about the water-level data collected by USGS Water Science Centers and supplied by USGS partners through cooperative agreements. The *Active Groundwater Level Network* contains water levels and well information from more than 25,000 wells that have been measured by the USGS or USGS cooperators at least once within the past 365 days. Additionally, the *Climate Response Network* of more than 500 wells was developed and continues to be maintained to assess changes in groundwater conditions due to climate stresses, such as drought. The groundwater climate response network, although small, continues to grow as the public, water managers, and scientists better understand the connection between climatic variations and shallow groundwater aquifers. A *Real-Time Groundwater Level Network* monitors groundwater level data at about 1,200 wells. More than 14,000 wells are part of the *Long-Term Groundwater Data Network,* which consists of periodic, continuous, and (or) real-time wells with at least 20 years of measurement. Finally, more than 9,000 wells in the *High Plains Aquifer Monitoring Network* are measured annually by an assortment of government agencies and the USGS to assess water-level changes in the High Plains aquifer.

As a complement to these networks and in response to expanding human and environmental demands, the USGS periodically evaluates water levels on a regional scale to properly inventory groundwater reserves in areas experiencing intense development. Other aquifers and aquifer systems have been and are being monitored, such as the Atlantic Coastal Plain Aquifer System, the Sparta-Memphis Aquifer, the Columbia Plateau Regional Aquifer System and the Floridan Aquifer System.

The USGS is the lead Federal agency on the Advisory Committee on Water Information (ACWI) Subcommittee on Ground Water (SOGW). SOGW designed a framework for a National Ground Water Monitoring Network (NGWMN) during 2007-2009 as referred to in the SECURE Water

Act. The NGWMN is proposed as a collaborative monitoring network among Federal, Tribal, State, local agency data providers. Five 1-year pilot projects have been selected and are set to be completed by early 2011.

Technical Support

(Estimates for 2009, $1.8 million; 2010, $1.9 million; 2011, $1.9 million)

This support provides quality control to assure the technical excellence of the groundwater field programs and provides a structured way of transferring new technology to activities that are conducted at USGS Water Science Centers in each State. This program component also provides a formal way of establishing research priorities and making groundwater information available to other agencies, the scientific community, and the public.

Major GWRP accomplishments anticipated from the Groundwater Resource Program in 2011 include:

- A USGS Professional Paper assessing groundwater availability of the Mississippi Embayment Regional Aquifer System (Arkansas, Louisiana, Mississippi, and Tennessee) will be released.

- The preliminary synthesis of the first five groundwater availability studies that eventually will make up the national assessment of groundwater availability will be conducted. The lessons learned from this initial analysis will help refine the remainder of the regional assessments.

- Ongoing investigations will be continued into their second year for three “challenge areas” directly linked to the regional groundwater availability studies. These are:

    - Assessment of saline groundwater resources;
    - Estimating groundwater withdrawals and consumptive use for principal aquifers; and
    - Monitoring the effects of climate change on groundwater resources.

- Several journal articles and reports on the development of new geophysical methods to improve understanding of hydrogeologic structure and processes will be released. The articles will focus on the development and application of fiber-optic distributed temperature sensing technology for hydrologic studies; development and application of rapid seismic, electromagnetic, and electrical resistivity imaging, characterization, and monitoring methods; and development of software for quantitative analysis of flowmeter, temperature, and geophysical tomography data.

- Enhancements and updates to USGS groundwater software will continue including the widely used MODFLOW groundwater-flow model and recently released GSFLOW coupled watershed model that is based in part on MODFLOW. Embellishments will include better representation of lakes in groundwater/surface-water simulations, improved methods for solving the finite-difference equations on which MODFLOW is based, and additional options to better evaluate the effects of existing and proposed groundwater-management activities. All of these enhancements will be distributed free of charge through the USGS Water Resources Software Web pages: *http://water.usgs.gov/software.*

- The SOGW will produce a report that summarizes the results of the five pilot projects examining groundwater level and quality monitoring data. The results from the pilot studies will then be used as a basis for a full-scale implementation of the data sharing portal and a national network for monitoring groundwater levels and quality.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of the Nation's 65 principal aquifers with monitoring wells used to measure responses of water levels to drought and climatic variations to provide information needed for water-supply decisionmaking **(SP) (GWRP)**	C	61%	60% (39/65)	58% (38/65)	62% (40/65)	62% (40/65)	62% (40/65)	62% (40/65)	0	62% (40/65)
% of U.S. with ground water availability status and trends information to support resource management decisions **(GWRP)**	C	UNK	8% (3/40)	8% (3/40)	13% (5/40)	13% (5/40)	15% (6/40)	18%* (7/40)	+3%	20% (8/40)
Total projected cost ($000)		**UNK**	**1,050**	**1,125**	**2.050**	**2,050**	**2,700**	**3,185**	**+485**	**3,960**
Actual cost per water status product (whole dollars)		**UNK**	**350,000**	**375,000**	**410,000**	**410,000**	**450,000**	**455,000**	**+5,000**	**495,000**
Comments	*Enhanced performance associated with the WaterSMART Availability and Use Assessment effort will be realized in 2014 as this measure addresses studies that are completed as opposed to studies underway.									
# of knowledge products on the quality of the Nation's water resources provided to support management decisions **(GWRP)**	A	UNK	15	17	20	20	25	25	0	25
Total projected cost ($000)		**UNK**	**3,000**	**3,400**	**4,000**	**4,000**	**5,000**	**5,000**	**0**	**5,000**
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program Component: **National Water-Quality Assessment Program**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
National Water Quality Assessment Program	65,056	0	66,507	-1,465	0	65,042	-1,465
Total FTE	*380*	*0*	*379*	*-3*	*0*	*376*	*-3*

1) $1,008 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes

The 2011 budget request for the National Water-Quality Assessment Program (NAWQA) is $65,042,000 and 376 FTE. There are no program changes for NAWQA in 2011.

Program Overview

The NAWQA Program addresses three long-term goals:

- Describe the status and trends in the quality of a large, representative part of the Nation's surface-water and ground-water resources;
- Provide an improved understanding of the primary natural factors and human activities affecting these conditions; and
- Provide information that supports development and evaluation of management, regulatory, policy, and monitoring decisions by other Federal, State, and local agencies.

The full scale NAWQA program began in 1991. During its first decade, the program established a baseline understanding of water-quality conditions and conducted interdisciplinary assessments in 51 of the Nation's most important river basin and aquifer systems, referred to as Study Units. A new cycle of studies involving selected streams and aquifers in 42 of the 51 Study Units began in 2001 and is scheduled for completion by 2012. In 2009, planning for the next NAWQA cycle (2012-2023) began.

The goals of the NAWQA Program directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of NAWQA Program scientists also support USGS Science Strategy themes focused on understanding stream ecosystems and ecosystem change due to human and natural causes; and understanding the role of the water environment in human and ecosystem health. NAWQA works in conjunction with other USGS programs and an array of partner agencies.

To share program knowledge and to solicit external input on program direction, NAWQA managers coordinate extensively with Federal agencies such as the U.S. Environmental Protection Agency (EPA) and U.S. Department of Agriculture (USDA), State and local agencies, non-governmental organizations, and the private sector. For example —

- Innovative geo-spatial modeling (SPARROW), integrated with water-quality data from long-term (decadal) monitoring, are being used by the EPA Science Advisory Board and the Gulf of Mexico Nutrient and Hypoxia Task Force to inform and develop a basin-wide strategy to reduce the nutrient burden responsible for oxygen loss (or "hypoxia") in the Gulf of Mexico. SPARROW helps quantify the relative magnitude of urban and agricultural sources of nitrogen and phosphorus in the basin and describes the transport of these nutrients to the Gulf of Mexico. The areal extent of the hypoxic zone in the northern Gulf of Mexico is the second largest in the world, and threatens the economic and ecological health of one of the Nation's largest and most productive fisheries. Beginning in 2009, SPARROW findings also are being used by USDA and conservation partner organizations to help prioritize watersheds for implementation of nutrient management strategies, as part of the USDA Mississippi River Basin Healthy Watersheds Initiative (MRBI). SPARROW findings continue to be used by EPA and States to help define the concentrations of nutrients necessary to support healthy stream ecosystems across the country. The development and adoption of nutrient criteria is an integral part of State and tribal efforts to implement standards into their water quality programs.
- In concert with the Water Environment Federation, NAWQA hosted a congressional briefing in 2009 in Washington, D.C., open to the public, on the quality of water in more than 2,100 private wells located in 48 States—a drinking-water resource relied upon by about 43 million people—or 15 percent of the Nation's population. NAWQA findings on contamination and vulnerability of private wells in different regions of the Nation were presented with information on treatment options by the National Groundwater Association to help private well owners—currently not protected by the Federal Safe Drinking Water Act—to better manage the quality of their drinking water. In 2010, a congressional briefing will inform stakeholders and the public on the quality of water sampled from high-production community water systems across the Nation.
- In 2009, NAWQA scientists published a national assessment on mercury in fish, revealing mercury contamination in every fish sampled in nearly 300 streams nationwide. Mercury, a neurotoxin, is one of the most serious contaminants threatening our Nation's waters. In unmined areas, the main source of mercury to natural waters is mercury that is emitted to the atmosphere and deposited onto watersheds by precipitation. The information is used in current policy discussions within EPA related to controlling mercury sources in atmospheric deposition and setting mercury standards to protect the environment.

> "This study shows just how widespread mercury pollution has become in our air, watersheds, and many of our fish in freshwater streams. This science sends a clear message that our country must continue to confront pollution, restore our nation's waterways, and protect the public from potential health dangers." **(Secretary of the Interior Ken Salazar, August 2009)**

- NAWQA released a regional study on trends in several major pesticides in Corn Belt rivers and streams, which generally includes Illinois, Indiana, Iowa, Nebraska and Ohio, as well as parts of adjoining States. Concentrations mostly declined or stayed the same between 1996-2008, and declines in pesticide concentrations closely followed declines in their annual applications, indicating that reducing pesticide use is an effective and reliable strategy for reducing pesticide

contamination in streams. Declines in concentrations of the agricultural herbicides cyanazine, alachlor, and metolachlor show the effectiveness of EPA regulatory actions as well as the influence of new pesticide products. In addition, declines in concentrations of the insecticide diazinon from 2000 to 2006 correspond to the EPA's national phase-out of nonagricultural uses. The USGS works closely with the EPA, which uses USGS findings on pesticide trends to track the effectiveness of changes in pesticide regulations and use across the Nation.

- NAWQA findings from a regional study of water produced by the High Plains (or "Ogallala") aquifer, the Nation's most heavily used groundwater resource, were highlighted at the 2009 summer meeting of the Western States Water Council. The findings showed that water generally is acceptable for human consumption, irrigation, and livestock watering, but warns that concentrations of contaminants such as nitrate and dissolved solids are moving from the water table to deeper parts of the aquifer where drinking-water wells are screened because of the heavy use of water for irrigation and public supply and leakage down inactive irrigation wells. The increase in contaminant concentrations over time has important implications for the long-term sustainability of the High Plains aquifer as a source of drinking water for eight states: Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming.
- NAWQA completed a comprehensive study of chloride concentrations in the northern United States covering parts of 19 States showing elevated concentrations in many urban streams and groundwater. Chloride levels above the recommended Federal criteria set to protect aquatic life were found in more than 40 percent of urban streams tested. Elevated chloride can inhibit plant growth, impair reproduction, and reduce the diversity of organisms in streams. Use of salt for deicing roads and parking lots in the winter is a major source of chloride. Other sources include effluent from wastewater treatment facilities, septic systems, and runoff from farming operations. NAWQA findings remind us of the unintended consequences that salt use for deicing may have on our waters; State and local transportation officials continue to implement innovative alternatives that reduce salt use without compromising human safety.
- NAWQA continues to co-lead the National Water-Quality Monitoring Council (composed of more than 50 representatives from other Federal, State, Tribal, and local agencies, non-governmental organizations, industry, and academia) in their effort to develop consistent methodology; integrated water assessments; and national water monitoring networks that help to assess terrestrial impacts on our Nation's estuaries and coastal waters and Great Lakes. The efforts are directly relevant to coastal and marine spatial planning and the Ocean Action Plan. In addition, NAWQA continues to spearhead the development of common web services so that stakeholders can access data from multiple sources in a common format, which allows more comprehensive analyses of water quality and ecosystem health over broad geographic regions and of trends over time. These data activities support the Bureau's strategic direction to integrate earth science data from different sources to support more comprehensive and interdisciplinary information for models, decision-support tools, and scientific reports.

2011 Program Performance

At the proposed level, the program will continue national synthesis of selected topics; regional and national assessments of status and trends in streams and groundwater; studies of source-water quality associated with large community water systems; and five studies of national priority topics, including: (1) effects of nutrient enrichment on stream ecosystems; (2) sources, transport, and fate of agricultural chemicals; (3) transport of contaminants to public-supply wells; (4) effects of urbanization on stream ecosystems; and, (5) bioaccumulation of mercury in stream ecosystems.

NAWQA implements and supports outreach and liaison activities at local, State, regional, and national scales. NAWQA's Web site (*http://water.usgs.gov/nawqa /)* provides rapid access to NAWQA's methods documents, publications and products, and an up-to-date listing of current developments that allows interested parties to get new information in a timely fashion. The program hosts the largest online collection of nationally consistent water-quality data through its NAWQA Data Warehouse (*http://water.usgs.gov/nawqa/data/*), including concentrations in water, sediment, and aquatic tissues for 2,000 chemicals at over 8,000 stream sites and 8,100 wells, and fish, aquatic insect, and algal community data for more than 20,000 stream samples. All data from NAWQA collected during prior years will continue to be available for users in 2011.

In 2011, NAWQA will release an enhancement to the Data Warehouse for USGS aquatic ecological data. This centrally managed system will accommodate biology and ecology data on in-stream habitat and fish, aquatic insect, and algal communities (referred to as "NWIS-Biology"). NWIS-Biology was developed by NAWQA in partnership with the USGS Biological Resources Discipline, Geographic Information Office, and with other USGS programs such as Water Information Program, National Biological Information Infrastructure, and USGS Regions and Science Centers. This activity supports the USGS Science Strategy theme of data integration and advances accessibility of ecological information for enhanced understanding and assessments of ecosystem health.

Major products anticipated in 2011 include:

- Three USGS Circulars on NAWQA topical studies will be released, which will have high visibility and directly support the Bureau's strategic plans for providing science relevant to human and ecosystem health and changes in water quality and availability due to human and natural factors. These Circulars will compare, contrast, and summarize findings from studies completed across the Nation from 2002-2009 with major implications for water quality management in urban and agricultural watersheds and principal aquifers. Specifically, the information will describe:
    - The transport of natural and man-made contaminants to public wells;
    - Effects of urban development over the last 30 years on stream ecosystems, including effects on fish, algae, aquatic insects, and stream habitat; and,
    - Bioaccumulation of mercury in stream ecosystems across the Nation.
- A new 10-year plan (covering 2013-2023) for the NAWQA Program will be released that has been reviewed by the National Research Council and that will include recommendations on improvements to NAWQA's design and implementation to address the water-quality issues of the 21st Century.

NAWQA goals are accomplished using six major program elements. NAWQA Program activities for 2011 are described below.

National Synthesis of Key Findings Related to Important Water-Quality Topics
(Estimates for 2009, $7.0 million; 2010, $7.0 million; 2011, $7.0 million)

National synthesis topics cover pesticides, nutrients, and aquatic ecology, and to a lesser extent, volatile organic compounds and trace elements. Findings contribute to a comprehensive national-scale perspective on water-quality conditions and trends and key factors (such as land use, hydrology, geology, and soils) that govern water quality.

Regional and Study Unit Assessments of Status and Trends

(Estimates for 2009, $27.6 million; 2010. $29.2 million; 2011, $29.2 million)

Status and trend assessments focus on the quality of streams and rivers in the 42 Study Units grouped within eight major river basins in the United States, and the quality of groundwater in about one-third of the Nation's 62 principal aquifers. These broad-scale assessments integrate modeling with monitoring to help extend water-quality assessments to unmonitored, yet comparable areas. They also involve collaboration with other USGS programs, such as the National Stream Quality Accounting Network, other Federal agencies, and regional, State, Tribal, and local organizations to maximize the use of available data to achieve assessment goals. Source-water-quality assessments are conducted to characterize water in selected drinking-water supply wells, stream intakes, and in finished drinking water associated with large community water systems. The source-water quality assessments complement drinking-water monitoring required by other Federal, State, and local programs, which focus primarily on post-treatment compliance monitoring.

Topical Studies of National Priority

(Estimates for 2009, $10.1 million; 2010, $9.8 million; 2011, $9.8 million)

Topical studies address five national priority topics that establish links between sources and transport of contaminants, and the potential effects of contaminants on humans and aquatic ecosystems. The five topical studies are conducted in selected Study Units across the nation where these issues are a large concern. NAWQA relies on fundamental research accomplished in other water programs like the National Research Program and the Toxic Substances Hydrology program. For example, NAWQA collaborates with other USGS scientists on sampling and analytical techniques to understand key chemical and biological processes affecting water quality, such as mercury bioaccumulation in fish, stream metabolism, and contaminant degradation. The five national priority topics under study are:

- Effects of nutrient enrichment on stream ecosystems,
- Sources, transport, and fate of agricultural chemicals,
- Transport of contaminants to public-supply wells,
- Effects of urbanization on stream ecosystems, and
- Bioaccumulation of mercury in stream ecosystems.

Supporting Research and Methods

(Estimates for 2009, $6.5 million; 2010, $6.6 million; 2011, $6.6 million)

To ensure NAWQA data collection and analyses are relevant to emerging issues, about 10 percent of program resources is devoted to developing state-of-the-art methods of sample collection and analysis and to innovative research techniques, such as those involving age-dating, dye tracer tests, and isotope analysis.

Coordination at Local, State, Regional, and National Levels

(Estimates for 2009, $2.7 million; 2010, $2.8 million; 2011, $2.8 million)

NAWQA continues to assist the EPA's Office of Pesticide Programs; Office of Wetlands, Oceans, and Watersheds; Office of Ground Water and Drinking Water; and Office of Science and Technology, in the timely and relevant application of NAWQA data and predictive models to

those offices' decisionmaking processes. Partnerships and liaisons with environmental and natural resources managers, regulators, planners, and policy makers, from national to local, have involved over 1,500 organizations and individuals.

Technical Support of USGS Activities

(Estimates for 2009, $11.1 million; $11.1 million; 2011, $11.1million)

Providing national-level technical support and training is critical to NAWQA and other water programs to ensure the use of nationally consistent methods and approaches, and a high level of quality control and technical excellence for its geographically distributed water-quality studies. In 2011, this includes continued support for Bureau publishing centers and ongoing stable support for quality control to assure the technical excellence of water-quality field programs. The technical support activities provide a structured way of transferring new technology to investigative and data activities that are primarily conducted in USGS Water Science Centers in each State. Technical support also provides efficient and effective mechanisms to make water-quality information available to other agencies, the scientific community, and the public.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of U.S. with ground water quality status and trends information to support water resource management decisions **(NAWQA)**	C	UNK	18%	28%	38%	38%	48%	69%	+21%	100%
% of U.S. with streamwater quality data for status and trends assessment and information to support water resource management decisions **(NAWQA)**	C	UNK	18%	36%	53%	70%	87%	95%	+8%	95%
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(NAWQA)**	A	UNK	70	80	50	50	80	20	-60	30
Total projected cost ($000)		**UNK**	**14,000**	**16,000**	**10,000**	**10,000**	**16,000**	**4,000**	**-2,000**	**6,000**
Comment	The decrease in products produce is a result of completing publication products planned in Cycle 2 (2002-2012) of NAWQA and winding down our level of reporting out as we ramp up with new data-collection activities for cycle 3 (2013-2023). The number of reports will be below average in the first years of Cycle 3 and then be above average by about 2016 because of the lag time between sample collection and report publication.									
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program Component: **Toxic Substances Hydrology**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Toxics Substances Hydrology ($000)	10,767	0	11,084	-284	0	10,800	-284
Total FTE	*36*	*0*	*36*	*-1*	*0*	*35*	*-1*

1) $206 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes for Toxic Substances Hydrology

The 2011 budget request for the Toxic Substances Hydrology Program (Toxics) is $10,800,000 and 35 FTE. There are no program changes for the Toxics Program in 2011.

Program Overview

The Toxics Program is a water quality research program that provides reliable scientific information and tools that explain the occurrence, behavior, and effects of toxic substances in the Nation's hydrologic environments. The results of those efforts provide a foundation for informed decisionmaking by resource managers, regulators, industry, and the public.

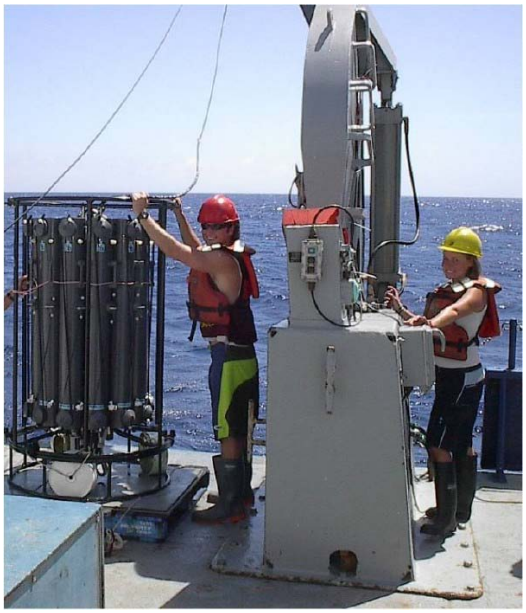
The contamination problems investigated by the Toxics program are widespread and pose significant risk to human health and the environment. Based on input from many agencies and organizations, the USGS identifies high priority problems for intensive, field-based research. These field studies are conducted at representative sites, watersheds, or regions that focus on subsurface-point-source or nonpoint-source contamination. Study results help water and environment managers improve environmental monitoring, characterize and manage contamination, develop best management practices, form regulatory policies and standards, register the use of new chemicals, and guide chemical manufacture and use. The program complements other USGS programs that monitor and assess the quality of the Nation's waters by focusing rapidly on new issues and on emerging and understudied contaminants, by identifying which issues warrant future attention, and by developing and improving the methods necessary for detecting and characterizing toxic substances in the natural environment.

The Toxics program's strengths are its long-term field-based approach, interdisciplinary research teams, ability to address contamination problems with a wide range of geographic scales and environmental settings, and fundamental scientific knowledge of the inherent clean-up capacity of our natural environments. Maintenance of long-term field research laboratories and data collection on extensive regional and national networks makes this contribution particularly unique.

The Toxics program works in partnership with other Federal agencies to ensure that priorities

A New Source of Methylmercury Entering the Pacific Ocean - A landmark USGS study, published in 2009, documents for the first time that mercury in the Pacific Ocean is from a human source. Previously, mercury in the Pacific Ocean was believed to originate from natural geologic sources, such as deep-ocean thermal vents. The study defines the process by which increased mercury emissions from human sources across the globe, and in particular from Asia, make their way into the North Pacific Ocean and as a result contaminate tuna and other seafood. The authors predicted an additional 50 percent increase in mercury in the Pacific by 2050 if mercury emission rates continue as projected. Water sampling cited in the study shows that mercury levels in 2006 were approximately 30 percent higher than those measured in the mid-1990s. The authors believe that mercury enters the ocean from the atmosphere and sinks to mid-ocean depths with “ocean rain.” Algae, which are produced in sunlit waters near the surface, die quickly and “rain” downward to greater water depths. At depth, the settling algae are decomposed by bacteria and the interaction of this decomposition process in the presence of mercury results in the formation of methylmercury, a highly toxic form that can more easily enter the food chain, where predators like tuna receive methylmercury from the fish they consume.

http://toxics.usgs.gov/highlights/pacific_mercury.html



Scientists on the vessel R/V Thomas G. Thompson lower a "rosette" of *12 Niskin bottles* to collect samples at various ocean depths. Photo courtesy of *William Landing, Florida State University*.

for science needs are coordinated, including other Interior Bureaus, the EPA, the USDA, the Department of Defense (DOD), the Department of Energy (DOE), the Nuclear Regulatory Commission, and more recently, public health agencies such as the Centers for Disease Control and Prevention, the Food and Drug Administration, and the National Institute for Environmental Health Sciences. As a science agency without a regulatory or resource management responsibility, USGS program information and methods often provide a basis for consensus in contentious issues and for achieving cost efficiencies by meeting the needs of numerous management and regulatory agencies. Scientists from universities, other Federal agencies, and industry find significant research opportunities through collaboration in Toxics program activities and at program research sites as evidenced by more than 150 student dissertations published as part of program research activities. Program results are distributed at briefings for regulatory agencies and industry groups, at workshops, at national scientific meetings, in USGS reports, and in scientific journals and books. In the last 5 years (2005–2009), the program contributed about 850 scientific publications.

The Toxics program coordinates with and complements a range of other USGS programs by:

- Providing new methods and information to monitoring and assessment programs such as the NAWQA program and National Stream Quality Accounting Network (part of the Hydrologic Networks and Analysis program);
- Addressing environmental effects of resource development with programs such as the Energy Resources and Mineral Resources programs; and,

- Evaluating the connections between environmental contamination of toxicological effects in fish and wildlife with the Contaminant Biology program.

The goals of the Toxics Program directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of Toxics Program scientists also support USGS Science Strategy themes of understanding ecosystems and predicting ecosystem change, providing a scientific foundation for energy and minerals resources for America's future, and the role of the environment and wildlife in human health.

Toxics program activities over the next 5 years are being guided by *The U.S. Geological Survey, Toxic Substances Hydrology Program Five-Year Plan, 2007–2011*, which was developed with broad input from stakeholders and from other USGS programs.

More information about the Toxics program is available on the Web at *http://toxics.usgs.gov/*.

2011 Program Performance

Major components of the program for 2011 include:

Investigations of Subsurface, Point-source Contamination
(Estimates for 2009, $5.0 million; 2010, $5.1 million; 2011, $4.9 million)

Interdisciplinary USGS research teams conduct long-term intensive field investigations of common types of subsurface contamination in a variety of hydrogeologic environments. These investigations provide information that improves capabilities to describe, manage, and remediate contamination from local sources, such as chemical spills, leaking storage tanks, industrial discharges, and leakage from landfills and other waste facilities. This knowledge and new methods are applied to similar sites across the Nation. The Toxics Program is viewed by those responsible for contaminated site cleanup as a unique provider of information and methods on issues such as contamination in fractured rock aquifers and long-term performance of monitored natural attenuation. This program component also includes development of field methods and techniques for more cost-efficient characterization of subsurface contamination. In 2011, the program will contribute to subsurface point-source contamination issues associated with:

- Hydrocarbons, fuel oxygenates, and other petroleum-related contaminants;
- Mixed (radionuclide and conventional) waste disposal and contamination in arid environments;
- Contamination in fractured-rock aquifers; and
- Contaminant plumes with complex chemical mixtures, such as landfills and treated wastewater discharges.

During 2011, highlights of the research activities of this program component include: (1) contaminant exchange with the rock matrix and testing innovative remediation alternatives in fractured rock aquifers; (2) residual hydrocarbons in the unsaturated zone above the water table as a contributing source to contaminant plumes; (3) volatile organic chemicals on the transport of tritium (radioactive hydrogen isotope) in the subsurface; (4) modeling contaminant transport

processes at the plume scale; and (5) characterizing microbial degradations pathways. Research on remediation alternatives are being coordinated with EPA, DOD, and DOE, via the Strategic Environmental Research and Development Program.

Investigations of Watershed-scale and Regional-scale Contamination

(Estimates for 2009, $5.1 million; 2010, $5.4 million; 2011, $5.3 million)

Watershed-scale and regional-scale investigations address nonpoint-source contamination problems typical of widespread land uses or human activities that may pose a threat to human and environmental health throughout a significant portion of the Nation. These investigations involve characterizing contaminant sources, investigating the mechanisms by which nonpoint-source contamination affects aquatic ecosystems, and investigating the processes that transform contaminants into different and possibly more toxic forms. This program component also includes development of laboratory and field methods to ensure accurate measurement of environmental contaminants at low levels.

New Approach to Evaluating Selenium Toxicity in the Environment - USGS scientists proposed an ecosystem-scale model of the fate of selenium in the environment. The model conceptualizes and quantifies how selenium is transferred from water through diet and into the food web. The model integrates the chemistry of biological and geological systems and the physiological factors that control how various animals within the food web, such as predatory fish and birds, bioaccumulate selenium. This new model will help ecologists, who currently use a range of inconsistent approaches, assess selenium toxicity in rivers, estuaries, and other water bodies. The model has been validated using 29 case studies and has the ability to forecast toxicity under different regulatory proposals.

http://toxics.usgs.gov/highlights/se_model.html

During 2011, highlights of the research activities of this program component include: (1) developing approaches to setting restoration targets in mined watersheds considering both pre-mining conditions and biological recovery resulting from remediation; (2) defining environmental contamination by understudied fungicides and insecticides in common pesticide-use settings; (3) developing a national evaluation of the susceptibility of aquatic ecosystems to mercury methylation and biomagnifications; and (4) characterizing environmental contamination by pharmaceuticals and other contaminants used in concentrated animal feeding operations and other sources to the environment, as well as in source (untreated) and finished (treated) drinking water.

Technical Support

(Estimates for 2009, $0.6 million; 2010, $0.6 million; 2011, $0.6 million)

The USGS has a long tradition of providing national technical support for its geographically distributed water resources studies. This support provides quality control to ensure the technical excellence of water resources field programs and provides a structured way of transferring new technology to investigative and data activities that are primarily conducted in USGS Water Science Centers in each State. Technical support also includes a formal way of establishing priorities for water research by the USGS and provides a mechanism to make water resources information available to other agencies, the scientific community, and the public.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of targeted contaminants on annual target list for which methods are developed to measure environmental occurrence and assess potential health significance **(SP)** **(Toxic)**	C	85%	41% (78/188)	48% (138/287)	33% (76/230)	27% (62/232)	33% (64/196)	30% (59/196)	-3%	30% (59/196)
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(Toxic)**	A	UNK	194	149	UNK	128	115	115	-5	110
Total projected cost ($000)		**UNK**	**38,800**	**29,800**	**UNK**	**25,600**	**23,000**	**23,000**	**0**	**22,000**
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program: **Hydrologic Research and Development**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011			Change From 2010 (+/-)
				DOI-Wide Changes [1, 2] (+/-)	Program Changes (+/-)	Budget Request	
Hydrologic Research & Development ($000)	13,421	0	13,822	-266	-1,600	11,956	-1,866
Total FTE	*214*	*0*	*213*	*-1*	*0*	*212*	*-1*

1) $200 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Hydrologic Research and Development

Request Component	($000)	FTE
• Unrequested Congressional Increases	-1,600	0
TOTAL Program Changes	**-1,600**	**0**

Justification of 2011 Program Changes

The 2011 budget request for the Hydrologic Research and Development (HR&D) Program is $11,956,000 and 212 FTE, a program change of -$1,600,000 and 0 FTE from the 2010 Enacted level.

Unrequested Congressional Actions **(-$1,600,000/0 FTE)**

This reduction will end three unrequested congressional actions. These projects are not Administration priorities and do not address the highest priority Water Resources science needs. This reduction will allow the core Program to remain intact while allowing the USGS to make the best use of available resources. The specific projects are the Hood Canal Dissolved Oxygen Study (-$200,000), the Long Term Estuary Assessment Group (LEAG) (-$400,000) and the U.S.-Mexico Transboundary Aquifer Assessment Act (-$1,000,000).

Program Overview

The HR&D program conducts long-term research on complex problems in the hydrologic sciences and supports the research and development needs of other water resource and USGS programs. HR&D program investigations integrate hydrological, geological, chemical, climatic, and biological science in addressing water resources issues. The program maintains a balance between high-risk, high-reward research that leads to major scientific breakthroughs and future applications, and more applied research that helps keep the program relevant and focused on today's water resource issues. The efforts of the HR&D program are typically multidisciplinary

in nature and require strong collaborative relations, both among scientists funded by the program and with scientists in other USGS programs, in Federal and State agencies, universities, and foreign countries.

The long-term goals of HR&D are to improve understanding of:

- Ecological and biogeochemical processes in the hydrologic cycle and the role of natural and human-induced changes on these processes that can inform sound management of water quantity, quality, and biological resources;
- Chemical and biochemical processes affecting chemical constituents in aquatic systems to enable evaluation of water quality, helping managers make informed water-management decisions;
- The physical processes controlling the distribution of the Nation's surface-water resources to mitigate floods and droughts;
- The movement, availability, and transport of subsurface water in order to minimize further contamination of the Nation's groundwater, optimize aquifer remediation efforts, and ensure effective groundwater management;
- Stream-channel morphology and erosional processes governing the source, mobility, and deposition of sediment to improve management of rivers, dams, and reservoirs; and
- Long-term processes in small watersheds, including the effect of atmospheric and climatic variables, and provide water and land managers with information needed for water resources management.

National Research Program in the Hydrologic Sciences

A key component of HR&D is the USGS National Research Program (NRP). NRP scientists often take a lead role in designing and conducting complex projects, bringing advanced scientific thinking and tools to the project. The NRP has provided expertise essential for making science-based decisions in many areas of the country where large-scale ecosystem study is underway (Everglades, San Francisco Bay Delta, the Grand Canyon). The NRP also provides expertise in areas related to carbon sequestration, denitrification, and hydrologic response to climate change.

NRP scientists also provide leadership and scientific services through teaching formal training courses for the USGS and cooperating agency staff, participating in reviews of USGS programs and Water Science Centers nationwide, and developing new programs.

The goals of the HR&D Program directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of HR&D Program scientists also support USGS Science Strategy themes of climate variability and change, understanding ecosystems and predicting ecosystem change, providing a scientific foundation for energy and mineral~~s~~ resources for America's future, a National hazards risk, and resilience assessment program, and the role of the environment and wildlife in human health.

Research conducted by scientists in the HR&D Program refines existing groundwater and watershed models and develops new modeling techniques to describe uncertainties and forecast changes in the hydrologic cycle. These efforts directly support the new USGS

WaterSMART Availability and Use Assessment. Ongoing research activities described in the program performance section have significantly contributed to our understanding of climate change impacts on water supply and our basic understanding of climate variability and change. Research in HR&D is conducted in conjunction with other USGS programs and an array of reimbursable projects funded by partner agencies.

2011 Program Performance

In support of other USGS programs, HR&D scientists conduct research in collaboration with scientists in other USGS programs and provide training, workshops, reviews, and advice on water resource issues to respond to national, regional, and local needs; provide specialized laboratory services, such as chemical and isotopic analyses and methods to characterize microbes; and develop new geophysical and geochemical techniques and numerical modeling tools.

The program includes two components:

Long-term interdisciplinary research
(Estimates for 2009, $12.3 million; 2010, $12.2 million; 2011, $11.9 million)

The long-term interdisciplinary research funded by the program provides core funding for the NRP, which draws from other USGS programs for about 57 percent of its appropriated funding and also leverages resources from other Federal and State agencies. These linkages ensure that research efforts are focused on developing new concepts and future techniques that are relevant to USGS programs and the Department. The NRP focuses on long-term investigations that integrate hydrological, geological, chemical, climatological, and biological information relating to water-resources and environmental problems. Study results provide the scientific basis that enables the USGS to tackle and resolve complex hydrologic problems.

HR&D scientists work in all six USGS Science Strategy science priority areas; however, there is particular emphasis on Ecosystems, Climate Variability and Change, and A Water Census of the United States. Several forms of internal and external reviews are used to evaluate progress in the HR&D program. Plans and accomplishments of each scientific project are internally reviewed on a yearly basis. In addition, in-depth reviews of each project and associated personnel are conducted on a 3-year cycle to examine the relationship of project work to the USGS mission; productivity, relevance, and scientific impact; and plans and goals for the next 5 years.

Groundwater modeling of nitrate transport to the Chesapeake Bay—Recent USGS investigations of nitrate transport to the Chesapeake Bay have focused on age-dating and computer modeling of groundwater flow paths. This is in contrast to the surface-water analysis that was the focus of earlier computer model studies. The recent data and research show that groundwater may account for over three-fourths of the nitrate loading, and both data and modeling indicate that nitrate typically takes decades to travel from the land surface to the Bay. The USGS computer models generate maps that will help land-use managers target areas that will likely produce the greatest and quickest responses to reduction in nitrogen loading at the land surface.

Perchlorate: From the Stratosphere to the Atacama Desert to Long Island groundwater— Pechlorate (ClO_4^- **),** which affects human thyroid function, is a common contaminant related to solid rocket fuel and explosives. Recent research has developed new isotope forensic

techniques to distinguish natural versus synthetic perchlorate in water, soil, and plants. These isotopic studies are linking Chilean fertilizer to U.S. groundwater and have provided new evidence that natural perchlorate is produced in the stratosphere. These new findings show that natural perchlorate is widespread, much of it from historical use of fertilizers imported from outside the United States.

Molecular microbiology work on coalbed methane—Coalbed methane (CBM), also referred to as coalbed natural gas, is a significant energy resource, accounting for about 10 percent of natural gas production in the United States. The importance of CBM and other unconventional natural gas resources in the U.S. energy mix is anticipated to increase during coming decades. NRP microbiologists are developing an understanding of the environmental factors that control generation of secondary biogenic methane in coal beds; such as the bioavailability of coal carbon, the presence of a microbial community to convert coal carbon to methane, and an environment supporting microbial growth and methanogenesis.

Short-term Research

(Estimates for 2009, $1.2 million; 2010, $1.2 million; 2011, $0 million).

Occasionally, HR&D receives funds, as a result of unrequested Congressional action, for short-term research on specific water issues. This portion of the program has included research to determine the causes of low dissolved oxygen and fish mortality in Hood Canal, WA; work to investigate the biogeochemical cycle of Gulf of Mexico hypoxia; and support for water availability assessment studies in the U.S.-Mexico Transboundary Aquifer. Funding for these short-term research activities is not requested in 2011.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(HNA)**	A	UNK	276	249	203	203	220	220	0	220
Total projected cost ($000)		**UNK**	**55,200**	**49,800**	**40,400**	**40,400**	**44,000**	**44,000**	**0**	**44,000**
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program Component: **National Streamflow Information Program**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2009 (+/-)
National Streamflow Information Program ($000)	22,406	14,625	27,732	-578	0	27,154	-578
Total FTE	*49*	*0*	*49*	*-2*	*0*	*47*	*-2*

1) $236 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes

The 2011 budget request for the National Streamflow Information (NSIP) Program is $27,154,000 and 47 FTE. There are no program changes proposed for NSIP in 2011.

Program Overview

The mission of NSIP is to provide the streamflow information and understanding required to meet national, regional, State, and local needs through five major objectives:

- Develop an enhanced streamgaging network that meets national needs for streamflow information that are fully funded by NSIP. This baseline network is supplemented by streamgages funded in partnerships to meet State, regional, and local needs.
- Improve the timeliness, reliability, and convenience of streamflow information delivery to users. This includes robust and redundant data delivery systems that ensure continued availability of data during catastrophic events and improved storage, retrieval, and data analysis abilities.
- Complete regional assessments of existing streamflow information to identify trends and to estimate streamflow at locations without streamgages. The trends would help indentify the effects of land use, water use, and climate changes.
- Improve the understanding of floods and droughts through expanded measurements and analyses.
- Perform and fund research and development activities to advance equipment technologies and measurement and analysis techniques for greater accuracy and at a lower cost of providing streamflow information.

Other USGS Programs rely heavily on NSIP for basic streamflow information required for their analyses. Among them are NAWQA which uses streamflow information to obtain estimates of contaminant loads and the Global Change program that requires long-term, natural flow information to assess the effects of climate change on the timing and quantity of water available. The GWRP uses streamflow information to estimate the relationship between surface water and

groundwater. The new USGS WaterSMART Availability and Use Assessment effort will require streamflow information to assess water availability in different regions. Aquatic biology programs (such as the Fisheries Program) require streamflow information to help determine the timing and quantity of river flow required for different habitats and species. In addition, other Federal agencies are dependent upon the streamflow data and information provided by. These include the National Weather Service for predicting floods, the Federal Emergency Management Agency for estimating flood prone areas, the National Park Service for managing the water resources, the U.S. Army Corps of Engineers for the operation of locks and dams, and the Bureau of Reclamation for dam and water conveyance systems operation. State and local water management agencies are also highly dependent on NSIP-provided streamflow information to manage and plan water uses.

NSIP's Federal Needs for Streamflow Information

Five Federal goals have been identified as those that should be met by the core set of USGS-funded streamgages in NSIP.

Sentinel Watersheds - A network of streamgages is needed to describe responses to changes in climate, land use, and water use in 800 watersheds across the country that are relatively unaffected by flow regulation or diversion and typify major ecoregions and river basins.

Interstate and International Waters - Interstate compacts, court decrees, and international treaties mandate long-term, accurate, and unbiased streamgaging by the USGS at State-line crossings, compact points, and international boundaries.

Streamflow Forecasts - Real-time stage and discharge data are required to support flood and other streamflow forecasting by the National Weather Service and other Federal agencies across the country.

River Basin Outflows - Resource managers need to account for the contribution of water from each of the Nation's 350 major river basins to downstream basins, estuaries, oceans or the Great Lakes.

Water Quality - Streamgaging stations are needed to provide streamflow information in support of national USGS water-quality networks that cover the Nation's largest rivers; intermediate-sized rivers; and small, pristine watersheds.

Federal NSIP streamgages reflect that portion of the National Streamgage Network to be funded exclusively by USGS direct appropriations. New program funds in 2010 allowed the Program to reestablish recently-discontinued streamgages and offset a reduction in funding from State and local agencies to support the operation and maintenance of additional existing streamgaging stations essential to monitoring streamflow and variation in streamflow as a result of climate change. This NSIP increase provided much needed funds to Water Science Centers for the operation and maintenance of threatened streamgages.

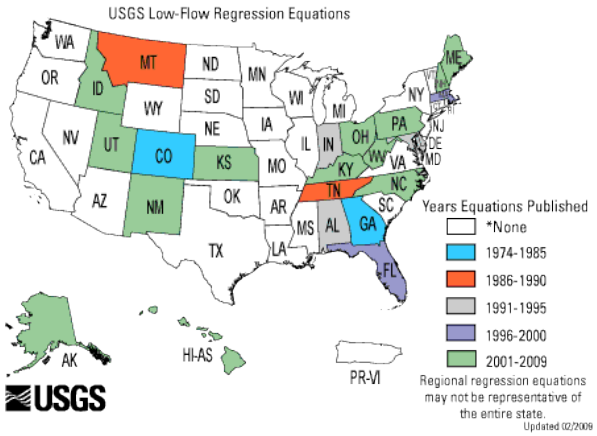
The USGS streamgage network provides relevant, high-quality information to all users, for a wide variety of uses, at a reduced cost to the Federal Government. Data are collected using nationally consistent methods, which enable comparability of data across jurisdictional boundaries and acceptance of results by water management agencies and courts at all levels of government. Data collection and information management infrastructure are consolidated at the USGS which minimizes the cost of providing national streamflow information.

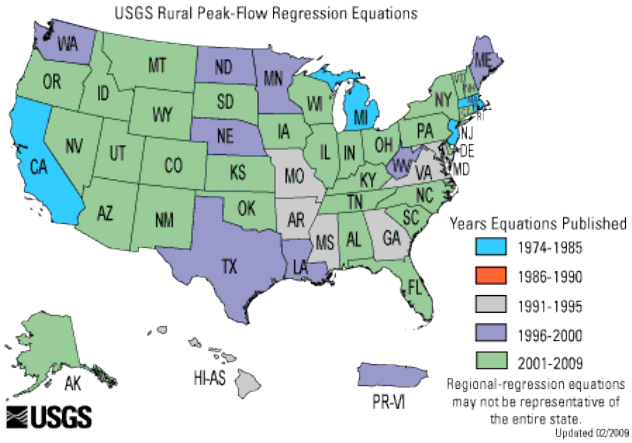
Recent hurricanes such as Katrina and Rita vividly demonstrated that storm surge can be as dangerous as riverine floods. To determine the timing, extent, and magnitude of hurricane-driven surge waters and waves, the USGS designed and developed a network of rugged, inexpensive water-level and barometric-pressure sensors, called storm-surge sensors, which can be quickly installed in anticipation of a storm. The information from these sensors is used to calibrate the storm-surge models employed by forecasters along the Gulf and Atlantic Coasts and helps them provide improved forecasts of areas and depths of inundation expected.

The goals of the NSIP program directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. Program efforts also support USGS Science Strategy themes of Understanding Ecosystems by providing streamflow information for organism life-cycle understanding and for defining natural conditions; (2) Climate Change by providing information on the changes in the hydrologic system due to changes in both precipitation and temperature; (3) Energy and Minerals by providing information on streamflow for hydropower and for cooling needs; and (4) for Hazards by defining expected hydrologic extremes for both floods and droughts.

2011 Program Performance

Flood and Drought Frequency Evaluations: Streamflow information collected as part of NSIP is used to provide equations for estimating the magnitude and frequency of floods and droughts. These equations are used for planning purposes and for the protection of lives and property. The equations require updating about every 10 years to account for changing conditions. In the last decade, 28 States have had new flood frequency equations provided by the USGS and 13 low flow (drought) predicative equations.





USGS Flood Participation and Activities: NSIP, along with numerous other funding sources, helped enable the USGS to collect crucial real-time streamflow data in the Red, Minnesota, Missouri, and James River basins during the Winter/Spring 2009 Northern Great Plains floods. USGS made over 1,200 streamflow measurements at more than 150 streamgages and installed Rapid Deployment Gages at 15 locations, all in support of flood forecasting and (or) emergency operations. The USGS collected 28 special discharge measurements at the James River above Arrowhead Lake near Kensal, ND, in order to define the flow going into the Jamestown Reservoir.

Program activities fall into the following major categories:

Federal Network Operations
(Estimates for 2009, $13.8 million; 2010, $17.5 million; 2011, $16.8 million)

This program component is dedicated to maintaining and operating a stable, reliable, and continuous nationwide Federal-interest streamgaging network for measuring streamflow and related environmental variables (precipitation, temperature).

Hydrologic Extremes
(Estimates for 2009, $0.1 million; 2010, $0.15 million; 2011, $0.15 million)

This program is designed to improve the understanding of hydrologic extremes (floods and droughts) by more intensive data collection during and immediately following the event and analyses of the information collected.

Regional Streamflow Assessments
(Estimates for 2009, $0.5 million; 2010, $0.6 million; 2011, $0.6 million)

NSIP-funded scientists provide regional assessments and interpretation of streamflow information to provide estimates of streamflow at ungaged locations and to identify trends in streamflow due to changing land use, water use, and climate change. These types of regional products directly support the USGS Science Strategy priority of a national water census to inform the public and decisionmakers about resource availability. As the effects of climate change on water resources are better understood, it is recognized that the existing streamflow information must be evaluated to identify trends in streamflow. This will enable water resource managers to plan more effectively for future water supplies. Climate change will potentially effect the location, frequency, and severity of floods and droughts. In 2011, methods and technologies will be investigated and developed for future applications.

Real-Time Information Delivery
(Estimates for 2009, $1.8 million; 2010, $2.1 million; 2011, $2.2 million)

NSIP works with staff from NWIS, the NWIS Web application (NWISWeb), and the USGS Office of Surface Water to develop, implement, and maintain a highly reliable system for real-time streamflow information delivery to customers that includes data processing, quality assurance, storage, and easy data access.

Development of Methods and Equipment
(Estimates for 2009, $1.5 million; 2010, $1.7 million; 2011, $1.7 million)

NSIP funds the investigation, development, and implementation of new methodologies and equipment to more accurately, safely, and inexpensively obtain and deliver streamflow information. Recent examples include expanded and enhanced use of the Doppler phenomenon to measure river velocity and discharge; use of radar to measure streamflow directly without instrumentation in the river; and statistical evaluation involving the transfer of flow characteristics from locations with a streamgage to ungaged locations.

Program Coordination

(Estimates for 2009, $0.5 million; 2010, $0.6 million; 2011, $0.6 million)

Critical to the continued success of NSIP are coordination efforts with other USGS programs, outside funding partners, stakeholders, and other interested parties. These efforts are central to the development and implementation of the short-term and long-term direction of the program and the approach to meet program goals.

Technical Support

(Estimates for 2009, $3.5 million; 2010, $3.8 million; 2011, $3.8 million)

NSIP provides for technical support for geographically distributed USGS water resources studies and data collection activities, including mechanisms for quality control, technology transfer, priority setting, and method and technology standarization. Technical support is critical to the continued success and benefit of the program.

Integrated Multi-Hazards Demonstration Project

(Estimates for 2009, $0.51 million; 2010, $0.51 million; 2011, $0.51 million)

In 2007, the USGS began an integrated Hazards Assessment and Mitigation Demonstration Project, focused on Southern California and the Gulf of Mexico coastal area. NSIP funding for that effort is used to support streamgages which provide data used in landslide predictions and tidal surges resulting from storms and in the aftermath of wildfires.

Energy Efficiency and Climate Change Initiative

(Estimates for 2009, $0; 2010, $0.75 million; 2011, $0.75 million)

These funds will be used to implement methods for improving estimates of irrigation and thermoelectric power generation water withdrawals across the Nation and will build upon the effort begun in 2010.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of river basins that have streamflow stations **(SP) (NSIP)**	C	81% (1800/ 2223)	81% (1800/ 2223)	79% (1765/ 2223)	84% (1765/ 2102)	81.4% (1712/ 2102)	84% (1765/ 2102)	84% (1765/ 2102)	0	86% (1800/ 2102)
Total projected cost ($000)		**24,300**	**24,300**	**24,710**	**26,475**	**24,824**	**26,475**	**26,475**	**0**	**27,000**
Actual cost per water status product (whole dollars)		**13,500**	**13,500**	**14,000**	**14,500**	**14,500**	**15,000**	**15,000**	**0**	**15,000**
% of the proposed streamgages in the National Federal Streamgaging Network, providing streamflow information for interstate and international waters, streamflow forecasts, river basin outflows, sentinel watersheds, and water quality transport **(NSIP)**	C	UNK	62% (2940/4757)	62% (2940/4757)	64% (3030/4757)	64% (3030/4757)	64% (3030/4757)	64% (3030/4757)	0	63% (3000/4757)
Total projected cost ($000)		**UNK**	**39,690**	**41,160**	**43,935**	**43,935**	**45,450**	**45,450**	**0**	**45,000**
Actual cost per water status product (whole dollars)		**13,500**	**13,500**	**14,000**	**14,500**	**14,500**	**15,000**	**15,000**	**0**	**15,000**
Discontinued streamgages, cableways, and ground-water well remediated **(ARRA) (NSIP)**	A	UNK	UNK	0	0	0	890	399	-491	Projects completed in 2011
# of streamgages upgraded with high data rate radios to increase frequency of radio transmission **(ARRA) (NSIP)**	C	UNK	UNK	4,500	4,900	4,505	5,300	6,900	+1,600	7,500

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
% of discharge measurements made with hydroacoustic instruments **(ARRA) (NSIP)**	C	UNK	UNK	35%	40%	67%	45%	70%	+25%	75%
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: **Hydrologic Monitoring, Assessments, and Research**
Program Component: **Hydrologic Networks and Analysis**

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Hydrologic Networks and Analysis ($000)	30,128	0	31,387	-1,761	+5,054	34,680	+3,293
Total FTE	*149*	*0*	*149*	*-7*	*+5*	*147*	*-2*

1) $399 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Hydrologic Networks and Analysis

Request Component	($000)	FTE
• USGS WaterSMART Availability and Use Assessment Initiative	+6,400	+5
• Unrequested Congressional Increases	-1,346	0
TOTAL Program Changes	**+5,054**	**+5**

Justification of 2011 Program Changes

The 2011 budget request for the Hydrologic Networks and Analysis (HNA) Program is $34,680,000 and 147 FTE, a program change of +$5,054,000 and 5 FTE from the 2010 Enacted level.

USGS WaterSMART Availability and Use Assessment Initiative (+6,400,000/5FTE)

In its early history, U.S. water management focused on alleviating or controlling the impacts of floods and droughts. Investments in water infrastructure such as dams and canals provided safe, abundant, and inexpensive sources of water, aided flood management, and dramatically improved health and economic prosperity. Today we are faced with a new set of water resource challenges. Aging infrastructure, rapid population growth, depletion of groundwater resources, impaired water quality associated with particular land uses and land covers, water needed for human and environmental uses, and climate variability and change all play a role in determining the amount of fresh water available at any given place and time. Water shortage and water-use conflict have become more commonplace in many areas of the United States—even in average water years. The impacts of climate change, energy development, rural and urban land use, and other increased human use on water resources quality and availability exacerbate the need for information and tools to aid water resource managers. This need was recognized by passage of the Omnibus Public Land Management Act of 2009 (P.L. 111-11) which called for, among other things, a National Water Availability and Use Assessment to provide information on water availability, and human and ecological use through a comprehensive and coordinated approach. The USGS Science Strategy, Circular 1309, *Facing Tomorrow's Challenges – U.S. Geological*

Survey Science in the Decade 2007-2017, identifies a Water Census of the United States as one of six USGS science priorities, and the Water Resources Investigations subactivity is positioned through its Hydrologic Networks and Analysis Program to provide the scientific underpinnings for a coordinated assessment of water availability and use. The basic structure of this effort will include:

- Estimates of freshwater resources and how those supplies are distributed and either increasing or decreasing over time;
- Evaluation of factors affecting water availability including energy development, changes in agricultural practices, increasing population, and competing priorities for limited water resources;
- Assessments of water use and distribution for human, environmental, and wildlife needs;
- Data and information needed to forecast likely outcomes of water availability, quality, and aquatic ecosystem health due to changes in land use and cover, natural and engineered infrastructure, water use, and climate; and
- A grant program to assist State water resource agencies in integrating State water use and availability datasets with Federal databases for a more comprehensive assessment of water availability.

Unrequested Congressional Actions (-$1,346,000/0 FTE)

This reduction will end three unrequested congressional actions. These projects are not Administration priorities and do not address the highest priority Water Resources science needs. This reduction will allow the core Program to remain intact while allowing the USGS to make the best use of available resources. The specific projects are the Lake Champlain Basin Toxic Material Study (-$346,000), Hawaii Water Resources Monitoring (-$500,000), and Maryland Coastal Plain Groundwater Modeling (-$500,000).

Program Overview

Data on the quantity and quality of water in the Nation's streams, lakes, and aquifers, as well as analytical studies, are necessary for the wise planning, development, utilization, and protection of the Nation's water resources. The Federal funds appropriated through the HNA program support three distinct water-quality networks described below, selected hydrologic analysis and modeling activities, and a small but vital portion of the overall information delivery activity of the USGS water resources programs.

The water-quality and hydrologic data and the analytical information provided by this program are used by a variety of stakeholders, including other Interior bureaus (through the National Park Service (NPS) water quality partnership), EPA and USDA (both customers for water-quality information), the NWS (for real-time flood level information provided through NWIS), State and local governments (for both water-quality and flood level information), academia, consulting and advocacy organizations, industry, and private citizens.

The goals of the HNA Program directly support the USGS Science Strategy focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of HR&D Program scientists also support USGS Science Strategy themes of climate variability and change and understanding ecosystems and predicting

ecosystem change. The HNA program is conducted in conjunction with other USGS programs and an array of reimbursable projects funded by partner agencies.

2011 Program Performance

Hydrologic Networks and Analysis includes four major components:

Hydrologic Networks
(Estimates for 2009, $5.9 million; 2010, $5.5 million; 2011, $5.1 million)

This program component includes long-term national networks for the collection of data on water quality and acid precipitation, including the National Stream Quality Accounting Network, the Hydrologic Benchmark Network, and the National Atmospheric Deposition Program / National Trends Network. This program component also includes activities related to the new National Water Quality Monitoring Network, a multi-agency effort conducted under the auspices of the Ocean Action Plan. The goals of this program component are to:

- Monitor the chemical quality of rain and snowfall;
- Monitor streamflow and the water quality of streams to fulfill USGS obligations for specific river basin compacts and treaties; and
- Monitor the water quality and trends of selected major rivers.

Hydrologic Analysis
(Estimates for 2009, $10.0 million; 2010, $10.1 million; 2011, $15.5 million)

This program component includes studies of climate variability and change, watershed modeling activities in support of the Bureau of Reclamation, USGS water-quality partnership with the NPS, and support for the USGS National Research Program in the hydrologic sciences. The new USGS WaterSMART Availability and Use Assessment effort is also included in this program component. The goals of this program component are:

- To provide direct technical support to Interior bureaus for hydrologic concerns;
- To provide direct technical support to the NPS for water-quality concerns; and
- To develop decision-support systems for specific river basins in the Western United States.

Coupling land hydrology to Global Climate Models – Research on techniques and methods to link climate models to hydrology and water resources is an ongoing effort. Recent results have demonstrated that climate models can be used to analyze historical and project future streamflow trends. These results have helped focus the attention of Intergovernmental Panel on Climate Change (IPCC) on projections of future changes in water availability. The NRP has had a key role in developing applications of climate change science to hydrology by identifying regional areas that will either become wetter or dryer in the future. In addition, the National Research Program is using some of the latest satellite technology (e.g., GRACE) to gain new insights into macrohydrology, supporting major innovations in the modeling tools used for improved projections, and impact analyses.

Warming and Water Supply Shortages in the Colorado River Basin– The high demand for water, the recent multiyear drought (1999-2007), and projections of global warming have raised questions about the long-term sustainability of water supply in the southwestern United States. Research on the potential effects of specific levels of atmospheric warming on water-year streamflow in the Colorado River basin are evaluated using a water-balance model, and the results are analyzed within the context of a multi-century tree-ring reconstruction (1490-1998) of streamflow for the basin. The results indicate that if future warming occurs in the basin and is not accompanied by increased precipitation, then the basin is likely to experience periods of water supply shortages more severe than those inferred from the long-term historical tree-ring reconstruction. Furthermore, the model results suggest that future warming would increase the likelihood of failure to meet the water allocation requirements of the Colorado River Compact.

Sea-level Rise in the San Francisco Bay – The National Research Program has produced the most up-to-date, high-resolution maps available of areas at risk of inundation around San Francisco Bay using LiDAR elevation data and a computer model of the Bay's waters. Maps are available for varying flood frequencies (1-year flood, 100-year flood, etc.) and a range of increases in mean sea level (up to 150cm or ~5ft). These maps are being used by regional government and planning agencies to plan for sea-level rise impacts to the San Francisco Bay.

Information Delivery

(Estimates for 2009, $4.4 million; 2010, $4.7 million; 2011, $5.0 million)

This program component includes delivery of results and water information beyond the immediate needs of funding agencies or programs (the USGS funds the delivery of basic hydrologic data directly as a part of the overall cost of the data collection). This activity has two products: publications and the computer-based NWIS. This component of the HNA program also supports activities of ACWI, a Presidential Federal Advisory Committee, and its subcommittees. The goal of this program component is to maintain and enhance USGS data delivery systems to process and disseminate water data and study results.

Technical Support

(Estimates for 2009, $9.8 million; 2010, $9.7 million; 2011, $9.1 million)

This program component includes national technical support for geographically distributed USGS water-resources studies, including quality control to ensure the technical excellence of water resources programs. Technical support also provides a structured way of transferring new technology to USGS investigative and data activities that are primarily conducted in the USGS Water Science Centers located in each State, and a formal way of establishing priorities for water-resources research by the USGS. In addition, this program component supports various Bureau-level activities such as CALFED science coordination.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(HNA)**	A	UNK	15	9	11	11	11	11	0	11
Total projected cost ($000)		**$0**	**$3,000**	**$1,800**	**$2,200**	**$2,200**	**$2,200**	**$2,200**	**0**	**$2,200**
% of the U.S. with completed, consistent water availability products that are used by partners for water resource management decision-making **(HNA)**	C	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	0% 0/2268	8% 180/2268	+8% 180/2268	16% 360/2268
Total Projected Cost ($000)		**0**	**0**	**0**	**0**	**0**	**0**	**$4,900**	**+$4,900**	**$9,800**
Comment	The addition of $4,900,000 will allow for a nationwide effort of water availability information to be initiated. In the first year, critical information will be developed characterizing water flows, storage, use, water quality and ecological needs. This initiative will be targeted at completing a nationwide coverage of this information over the next decade. The denominator is established as follows: 378 (total number of HUC units) x 6 (the number of water availability indicators to be examined in each HUC: (1) surface water; (2) storage; (3) precipitation; (4) evapotranspiration; (5) ecological flows; (6) water use). The numerator is the total number of indicators addressed nationwide.									
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

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Activity: Water Resources Investigations

Subactivity: Cooperative Water Program

	2009 Actual	2009 Recover Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Cooperative Water Program ($000)	64,078	0	65,561	-1,963	0	63,598	-1,963
Total FTE	*679*	*0*	*676*	*-20*	*0*	*656*	*-20*

1) $1,134 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes for the Cooperative Water Program

The 2011 budget request for the Cooperative Water (Coop) Program is $63,598,000 and 656 FTE. There are no program changes for the Cooperative Water Program in 2011.

Program Overview

For more than 100 years, the Coop Program has been a highly successful cost-sharing partnership between the USGS and States, local governments, and Tribes. This partnership provides support for a majority of the USGS national hydrologic data network, including approximately 4,700 of 7,500 streamgages, 10,000 groundwater observation wells, and 2,500 water-quality monitoring sites. The Coop Program is successful because it:

- Combines Federal and non-Federal resources in addressing many of the Nation's most pressing water resource issues, resulting in shared benefits and cost savings to both the Federal Government and the States;
- Conducts studies across the Country in each of the 50 States, Puerto Rico, and U.S. Trust Territories, allowing the USGS to form a national view of important water-resources issues and potential solutions;
- Uses standardized methods of data collection and analysis across the Country, so that information can be aggregated into national databases, results of studies are comparable from one State to another, and knowledge gained from one study has transfer value to understanding the hydrology in other parts of the country;
- Helps resolve inter-jurisdictional disputes by assessing conditions at and across State boundaries and by assuring all parties that the data and results of investigations are objective and are equally available to all parties; and
- Links State USGS offices with the larger national USGS infrastructure. This infrastructure includes the National Water Quality Laboratory, NWIS, the NRP, instrumentation testing facilities, a national quality assurance system, and the breadth of other expertise available throughout the Bureau.

In addition to providing information responsive to State or local needs, the Coop Program provides information that supports the activities of many Federal agencies. Some of these activities are:

- Forecasting floods
- Managing surface-water supplies
- Monitoring hydroelectric power demand
- Setting waste disposal limitations
- Regulating industrial discharges
- Designing highway structures
- Measuring the downstream transport of pollutants or nutrients
- Determining total maximum daily loads
- Evaluating mine permits
- Evaluating fish habitat
- Quantifying Federal reserved water rights
- Quantifying Indian water rights
- Managing interstate compacts and Indian water rights settlements

The goals of the Coop Program directly support the USGS Science Strategy and focus on providing scientific information on the water availability and quality of the United States as a means to inform the public and decisionmakers about the status of its freshwater resources and how they are changing. The efforts of Coop Program scientists also support USGS Science Strategy themes of understanding ecosystems and predicting ecosystem change, providing a scientific foundation for energy and mineral resources for America's future, climate variability and change, a national hazards, risk and resilience assessment program, and the role of the environment and wildlife in human health. The Coop Program is conducted in conjunction with other USGS programs and an array of reimbursable projects funded in cooperation with partner agencies.

This program effectively leverages Federal appropriations, working with State, local, municipal, and Tribal officials to develop a program that responds to both local and national needs and attracts more than two non-Federal dollars for each Federal dollar appropriated. This program of shared costs and shared benefits provides a foundation for the USGS national hydrologic networks that give USGS the ability to conduct regional and national water resource assessments. As the result of an antivipated reduction in cooperator funding, there may be a decrease in the hydrologic program and FTE supported by the Coop Program in 2011.

Program accomplishments in 2010 included:

Environmental Restoration: Chesapeake Bay River Input Monitoring (RIM) Program–2009 marked the 30th consecutive year that USGS monitored the quality of major rivers that drain to the Chesapeake Bay and measured the flux of nutrients and sediment being transported to the Bay. This long-term cooperative effort with the States of Maryland and Virginia and the U.S, Environmental Protection Agency provides essential information on one of the major stressors to the Chesapeake Bay and is used to determine the effectiveness of the multi-billion dollar effort to restore the Bay. Recent technical advancements in the RIM program have focused on improving statistical methods used to compute the amount and trends of nutrient and sediment delivery to the Bay and to effectively communicate those results to the public. The long-term commitment of USGS and its cooperative partners to provide this quality assured data and

information has been essential for scientists, policymakers, and the public to better understand the dynamics of nutrient delivery to the Bay and to develop effective nutrient management strategies in the Bay watershed. This work will need to be sustained for many years to come, as we continue to restore this valuable but highly stressed resource.

2009 Flood Response: Atlanta – The USGS maintains a network of real-time streamgages with rainfall sensors that provided critical hydrologic information during epic flooding in September 2009 that affected a vast area of the Atlanta metropolitan area. Post-storm analyses showed that this flood well-exceeded the 0.2 percent chance (500-year) flood magnitude at many locations. In comparing to other major floods nationwide, the Atlanta 2009 flood is now regarded as one of the most significant floods of the past century. USGS streamgages and interpretive analyses provided early warning to the National Weather Service, State and local emergency management officials, and county cooperators to make informed decisions in real-time concerning the protection of lives and property from floodwaters. According to William J. Higgins, Storm Water Division Manager of the Cobb County Water System, “Reading real-time data from the network of gages throughout the County and surrounding areas helped us direct Emergency Services to the points where they were needed most and may well have contributed to saving lives. Thankfully no lives were lost here in Cobb County during that flood, and I believe the USGS gages had a part in that.” Elsewhere in the Atlanta metro area, the flood resulted in more than $195 million in damages and 10 lives lost. Without the USGS streamgaging network in place and the efforts of USGS personnel to keep the network calibrated, Kent Frantz with the National Weather Service says that “losses from this flood would have been much worse” since citizens would not have been able to be warned to evacuate themselves and their property from threatened areas.

Water Availability: Yakima Basin Groundwater Assessment–In 2009, the USGS completed a 5-year assessment of the groundwater resources of the Yakima Basin in Washington State that resulted in 11 published reports. Like many Western U.S. basins, the Yakima basin water supply is considered to be over-allocated; there is growing demand for new uses; and there is a need to better understand the effects of surface and groundwater withdrawals so that water from these connected resources can be fairly allocated. This USGS study, conducted in cooperation with the Washington State Department of Ecology (Ecology), the Yakama Nation, and the U.S. Bureau of Reclamation (Reclamation) was designed to better define the occurrence of groundwater in the Yakima basin and determine its connection to surface water resources. The primary product of this work is a coupled groundwater and surface water computer model that can be used to assess potential management strategies and to estimate the extent of the effect that groundwater pumpage has on streamflow. The latter is important because senior surface-water rights, including Tribal water rights and in-stream flows for ESA-listed salmonids can be influenced by groundwater withdrawals. The project's products and tools will provide the necessary information to efficiently manage the precious water resources for both in-stream and out-of-stream uses. The USGS work is highly regarded by the stakeholders in the basin. According to Tom Mackie of the Washington State Department of Ecology Central Regional Office, "the work is of the highest quality, and the USGS is seen as more of an independent third party."

Resource Assessments: Nebraska Surficial Aquifers – In cooperation with local Natural Resources Districts, the USGS is deploying new geophysical techniques as an innovative methodology for efficiently characterizing Nebraska’s valuable groundwater resources. In 2009, the USGS conducted Helibourne Electromagnetic Surveys (HES) to characterize the hydrogeologic framework and water bearing capacity of Nebraska’s surficial aquifers. This new technology, being developed by the USGS in association with local, university, and international

partners, has proven successful in detecting water in a much more efficient and cost effective manner than traditional well drilling techniques. The HES surveys provide important information for better understanding the impacts of current and future groundwater withdrawals on both surface and groundwater resources. This information is of particular importance in managing groundwater withdrawals of over-appropriated or fully-appropriated river basins, such as the Republican, North Platte, and Central Platte river basins. Duane Woodward, Engineering Hydrologist with the Central Platte Natural Resources District, notes that the "study being conducted by the USGS in cooperation with Central Platte Natural Resources District (NRD) will provide valuable aquifer properties information to manage the groundwater resources across the Central Platte NRD," an area that encompasses one million acres of irrigated agriculture supplied by more than 17,000 high capacity water supply wells.

2011 Program Performance

The Coop Program includes three major components:

Data Collection Activities
(Estimates for 2009, $34.8 million; 2010, $35.6 million, 2011 $34.5 million)

Over the past few years, the Coop Program has provided sole Federal support or partial support for over half of the sites where the USGS collects data on surface-water levels and flow, groundwater levels, and groundwater quality. The Coop Program supports collection of data on surface-water quality, which is important to States to comply with the requirements of the Clean Water Act, and collection of streamflow data that are important to water supply planners to identify the influence of climate variability and climate change on water availability.

These data provide resource managers with the information they need to determine the suitability of water for various uses, identify trends in water quantity and quality, and evaluate the effects of various stresses on the Nation's groundwater and surface water resources. The data collected at USGS monitoring sites is provided free of charge on the Internet. This includes historical data as well as real-time data. The real-time data are used routinely by emergency management agencies, State and municipal agencies, businesses, irrigators, and recreational users.

Most USGS data collection stations serve multiple purposes and many are funded, wholly or in part, through joint-funding agreements. Normally, these stations, though funded by various organizations, are operated as part of an integrated network that provides benefits to a broad community of users and comprise the majority of the USGS national hydrologic data network.

Interpretive Studies
(Estimates for 2009, $23.1 million; 2010, $23.6 million; 2011, $22.9 million)

In addition to data collection activities, the Coop Program supports about 700 hydrologic studies each year. Water resource studies define, characterize, and evaluate the extent, quality, and availability of water resources. The results of these investigations are published and provided to cooperating agencies, which use them as the basis for managing the water resources for which they are responsible. Also, these investigations provide information that can be synthesized and applied to a variety of hydrogeologic and climatic settings across the Nation, greatly expanding the usefulness and transferability of USGS study results nationwide.

Technical Support

(Estimates for 2009, $6.2 million; 2010, $6.3 million; 2011, $6.2 million)

The USGS has a long tradition of providing national and regional technical support for its geographically distributed water resources studies. This support provides quality control to ensure the technical excellence of water resources field programs and assures that data collected by Water Science Centers in each State are of equivalent quality and suitable to be included in USGS national hydrologic data bases. Technical support also provides a structured way of transferring new technology to USGS investigative and data activities in each State, and provides a mechanism to make water resources information available to other agencies, the scientific community, and the public.

Topical areas of focus in 2011 align with the USGS Science Strategy and include the following:

Water availability —In 2011, the Coop Program will support thousands of streamgages and groundwater observation wells that define the availability of surface and groundwater, and will conduct numerous hydrologic investigations needed to evaluate the quantity and use of available surface and groundwater. These data and investigations will serve as a foundation upon which the proposed USGS WaterSMART Availability and Use Assessment will be built.

Drinking water —With many partners, the USGS is developing an understanding of natural and human factors that affect groundwater quality, providing early indications of potential water-quality problems and contributing to the long-term management and protection of groundwater resources affecting one in eight Americans.

Ecosystem services —Through the Coop Program the USGS is working with State and local agencies to evaluate the in-stream flow requirements of aquatic ecosystems, which addresses a key issue of water use for environmental and wildlife needs. This effort entails the development of both new information and new techniques.

Hydrologic Hazards — Real-time streamflow information from streamgages funded through the Coop Program is used by the NWS to provide flood forecasts to local communities. Local emergency responders use this same information in evacuating at risk populations from flooded areas. In addition, flood-frequency analyses conducted as a part of the Coop Program interpretive studies serve as the foundation for the design of flood control structures and delineation of flood prone areas, an essential component of the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program.

Program Performance Overview

End Outcome Goal 1.4: Improve the understanding of National Ecosystems and Resources through Integrated Interdisciplinary assessment.

End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
# of water monitoring sites supported jointly with State, local, and Tribal Cooperators where surfacewater and groundwater quality and quantity data are measured to support water resource management decisions related to water supply, the health and recreational value of aquatic ecosystems, and floods and droughts **(COOP)**	A	UNK	21,800	21,800	20,600	20,600	20,000	19,500	-500	19,000
# of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions **(COOP)**	A	UNK	250	250	237	237	230	225	-5	225
Total projected cost ($000)		**UNK**	**50,000**	**50,000**	**47,400**	**47,400**	**46,000**	**45,000**	**-1,000**	**45,000**
# of retrievals of groundwater and surface-water quantity and quality data and Information (GWRP)	A	UNK	108.19M	132.60M	153.98M	153.98M	166.30M	174.61M	+8.31M	183.34M

Activity: Water Resources Investigations

Subactivity: Water Resources Research Act Program

	2009 Actual	2009 Recovery Act	2010 Enacted	2011 Fixed Costs & Related Changes (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Water Resources Research Act Program Subactivity ($000)	6,500	0	6,500	-1	0	6,499	-1
Total FTE	*2*	*0*	*2*	*0*	*0*	*2*	*0*

1) $0 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Justification of 2011 Program Changes for Water Resources Research Act Program

The 2011 budget request for the Water Resources Research Act Program Subactivity is $6,499,000 and 2 FTE. There are no program changes for the Water Resources Research Act Program in 2011.

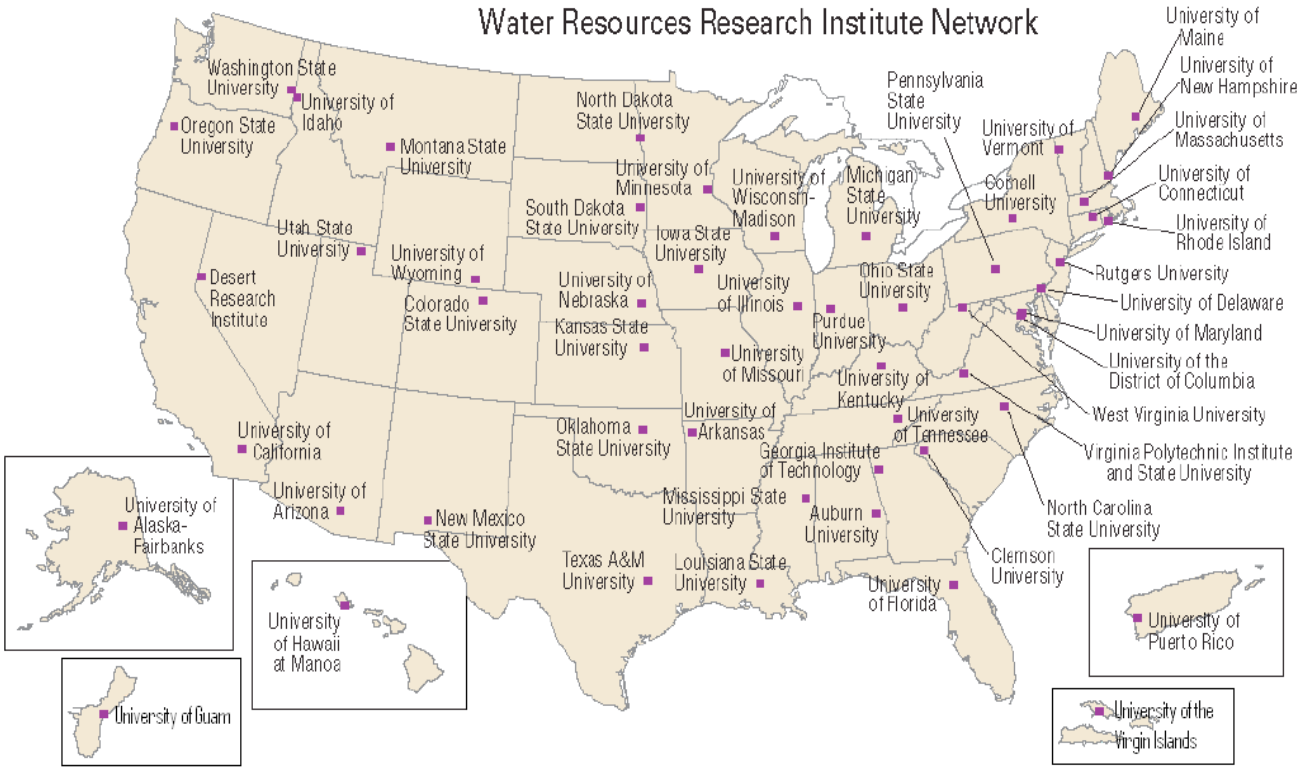
Program Overview

The Water Resources Research Act of 1984 established a Federal-State partnership in water resources research, education, and information transfer through a matching grant program that authorizes State Water Resources Research Institutes at land grant universities across the Nation. There are currently 54 Institutes: one in each State, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. The Guam institute also serves the Federated States of Micronesia and the Commonwealth of the Northern Mariana Islands.

The Institutes provide new opportunities for young people through their research and education efforts. Student internships supported by the Institutes provide an invaluable and practical training experience for the next generation of hydrologic scientists and engineers and afford students the unprecedented opportunity to participate in USGS projects while helping to influence their decision to pursue careers in water resources.

The Water Resources Research Act Program provides an institutional mechanism for promoting State, regional, and national coordination of water resources research, training and coordination and information and technology transfer. In 2009, the program provided training and support to over 500 undergraduate and graduate students by involving them in institute-sponsored research activities. With its matching requirements, the program is also a key mechanism for promoting State investments in research and training. In fact, the Institutes have developed a constituency and a program that far exceeds that supported by their direct Federal appropriation. According to the results of a recent survey conducted by the National Institutes for Water Resources, in 2007, the Institutes collectively generated an additional $17 in support for each dollar appropriated to them under the USGS program, with $8 coming from other

Federal sources and $9 coming from non-Federal sources.



Each Institute operates a program of multi-year research, education, and information transfer projects focused on State and regional water resource priorities. In 2009, the Institutes supported 225 applied research projects utilizing Federal and matching funds. These projects were selected in response to priorities established by the Institutes' advisory committees and through a competitive, peer-review process.

The following are examples of Water Resources Research Institute activities that have resulted in increased water supplies or yields and water quality improvements:

- The **University of California Center for Water Resources** has found that it is feasible to significantly reduce the amount of irrigation water used in citrus production by using partial root zone drying (PRD). The specific objectives included reduction of annual water use in a commercial navel orange orchard by alternately wetting and drying the root zone on two sides of the test trees using irrigation rates substantially lower than that received by the well-watered control trees under conventional irrigation. Using a strategy of reducing irrigation water to Washington navel oranges from January through July, then resuming irrigation to equal the rate of well-watered control trees, the trees receiving the PRD treatment produced fruit with an average diameter equal to that of the control trees by September, while using 27% less irrigation water over the period from January through September.

- The **West Virginia Water Resources Institute** has completed development of a nutrient credit trading program for the Potomac River drainage of West Virginia with support from the USDA Natural Resources Conservation Service. The 3-year stakeholder process produced two trading guidance documents: 1) general statewide guidance that will serve as the basis

for development of nutrient trading programs in other West Virginia basins; and 2) a Potomac River specific guidance that established criteria for trading among point and non-point sources (*http://wvwri.nrcce.wvu.edu/programs/pwqb/index.cfm*). With completion of this effort, nutrient trading programs are also in place in Maryland, Pennsylvania, and Virginia with hopes that these programs can be melded into an interstate trading program to help implement the Chesapeake Bay Total Maximum Daily Load (TMDL).

- The **University of Minnesota Water Resources Center** and LimnoTech, Inc. of Ann Arbor, Michigan have constructed a model that can be used to forecast the risk of contaminants of emerging concern in the Great Lakes. The basin-wide model uses estimates of air and water emissions of these contaminants and models their expected water concentrations, uptake by sport fish, and the health risk from humans consuming the fish. This screening tool is useful for evaluating which contaminants of concern pose potential risk in the Great Lakes.

- A collaborative research effort between the **Idaho Water Resources Research Institute** and the Idaho Department of Water Resources was a finalist for the Harvard Kennedy School's Innovations in American Government Awards. The project developed a tool to measure the amount of water consumed by irrigated agriculture across a large region or single field. Using surface temperature readings from satellites, air temperature and a system of algorithms, this tool lets water resource managers measure how much water is "consumed" on a given piece of land through evapotranspiration. The tool is called METRIC (Mapping EvapoTranspiration with High Resolution and Internalized Calibration) and is currently being used by 11 States.

2011 Program Performance

Funding in 2011 will allow the Institutes to continue their multi-year projects and other ongoing activities.

Program Performance Overview

Funding for the Institutes annually contributes to the training of over 600 students and the production of 1,000 publications. Interior is undergoing the required triennial review and update of its Strategic Plan. The Department is reviewing the organization and construct of the Strategic Plan in light of the Administration’s priorities, goals, and objectives. A key to transitioning the Strategic Plan to improved outcomes is the development of meaningful performance measures. As part of this effort, the USGS will work with the Institutes in 2010 to develop a performance measure that is consistent with the goals of the program and the Strategic Plan.

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Biological Research

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011 DOI-Wide Changes [1, 2] (+/-)	2011 Program Changes (+/-)	2011 Budget Request	Change From 2010 (+/-)
Biological Research and Monitoring ($000)	146,416	0	160,685	-3,014	+1,780	159,451	-1,234
FTE	*972*	*0*	*998*	*-8*	*+4*	*994*	*-4*
Biological Information Management and Delivery ($000)	21,965	0	24,946	-568	-1,628	22,750	-2,196
FTE	*74*	*0*	*73*	*-2*	*0*	*71*	*-2*
Cooperative Research Units ($000)	16,949	0	19,313	-170	0	19,143	-170
FTE	*126*	*0*	*141*	*0*	*0*	*141*	*0*
		0					
Total Requirements ($000)	**185,330**	**0**	**204,944**	**-3,752**	**+152**	**201,344**	**-3,600**
Total FTE	***1,172***	***0***	***1,212***	***-10***	***+4***	***1,206***	***-6***

1) $2,631 in fixed costs is absorbed ($2,164 in Biological Research and Monitoring, $167 in Biological Information Management and Delivery, and $300 in Cooperative Research Units).

2) See the General Statement and Section G for Details on DOI-wide Changes.

3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Activity Summary

The 2011 budget request for the Biological Research Activity is $201,344,000 and 1,206 FTE, a net program change of +$152,000 and +4 FTE from the 2010 Enacted level. Additional information on program changes is provided in each subactivity section and in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

The Biological Research Activity generates and distributes information needed for the conservation and management of the Nation's biological resources. This Activity serves as the Department of the Interior's biological research arm and continues the strong tradition of management-oriented research developed within the Department's land management bureaus. Core biological research capability at 17 research centers and associated field stations, one technology center, and 40 Cooperative Research Units supports research on fish, wildlife, and habitats that is used by Federal and State government and nongovernmental organizations.

Endangered Nene Geese in Hawaii. Photo Randolf Fenner

The USGS works closely with its scientific and management partners and customers to support the needs of resource management organizations. Biologists collaborate with scientists from other USGS disciplines and programs to develop science plans, conduct biological research and monitoring, and provide needed scientific information. Partners use information from research and monitoring to evaluate problems and options for restoring fish and wildlife habitats and to make better resource-management decisions concerning Departmental Trust species. Information management specialists participate in global scientific standards-setting bodies to ensure data sharing, exchange and integration capabilities. Information generated by the Biological Research activity helps to improve management of the Nation's water resources and the natural hazards that threaten its land, coastlines, and population. The Biological Research activity comprises three subactivities: Research and Monitoring, Information Management and Delivery, and Cooperative Research Units.

Program Review

BRD has initiated a Disciplinewide Programmatic Evaluation by an independent third party to examine all BRD research, monitoring, and information management activities. The charging document for the Review Panel was developed in consultation with OMB. The final report is pending from the Review Panel. Second, BRD also developed internal guidelines for conducting regular independent reviews its programs. A review of the Wildlife: Terrestrial and Endangered Resources Program was initiated and the recommendations from Review Panel are pending.

Science Strategy

The Biological Resources discipline (BRD) supports all of the themes in the USGS Science Strategy. Most of the work within BRD fits into the ecosystem theme and is informed by biological research on the state of the Nation's terrestrial, freshwater, and coastal and marine ecosystems, consisting of studies that address the causes and consequences of ecological change, and models that forecast the implications of natural and anthropogenic factors. BRD contributes to the climate element through investigations of the impacts of climate variables on species distribution and stressors, factors that affect biological carbon sequestration and other research. The energy and mineral development theme is informed by biological work on the effects of development of renewable energy on species and habitat, and the effects of contaminants in abandoned minelands. Biological information on wetland restoration and fire improves societal response to natural hazards such as hurricanes and fires. In the human health theme, biology is at the forefront of identifying wild-animal disease reservoirs, and maintains critical knowledge about exposure to humans from wild-animal disease and contaminants in fish and wildlife that may be consumed, pathogens in recreational beaches, and the use of wild animals as sentinels of human health. In addition, BRD supports the Water Census element by conducting work on the status and trends of freshwater fishery resources, helps to determine the environmental needs for water, and forecasts aquatic-ecosystem health caused by changes in land use and land cover, natural and engineered infrastructure, water

USGS provided scientific information on imperiled wildlife and fish to respond to California's Station Fire, which burned over 160,000 acres of the desert ecosystem.

use, and climate variability. Finally, central to all of USGS science themes, Biological Resources is a leader in the development of cyberinfrastructure in support of long-term data management, implementation of standards, development of tools for interacting with data, and provision of an authoritative data source for taxonomy.

Workforce Planning

Continued success in providing the Nation with outstanding biological science depends on developing and maintaining a flexible and skilled workforce that can take advantage of science and business opportunities of the future. The USGS Biology Research Grade Evaluation Office maintains a database that tracks the classification, research specialty and skills of all discipline Research Scientists. The Biology discipline continually reviews these data along with retirement projections and periodic skills assessment exercises to identify workforce gaps and future skills needs. Comprehensive profiles of the current workforce and anticipated hiring needs are continually updated to ensure that the discipline and USGS can meet future science needs.

South Carolina CRU Student, attaching a radio collar to a feral hog in Congaree National Park, SC

Within the Biological Resources Discipline, workforce planning is also exemplified by efforts in the Cooperative Research Units (CRU) program. With new funding in 2010, CRU worked with program cooperators and partners to reshape the workforce of natural resource professionals through strategic hiring, graduate and post-graduate training, and new emphases on experiential learning. CRU will continue efforts in each of these areas, and in particular will allocate its resources so as to enhance capacity for research and education in each of its university-based Fish and Wildlife Research Units.

Biological Research is composed of three subactivities, Research and Monitoring, Information Management and Delivery, and the Cooperative Research Units.

Research and Monitoring — The USGS serves the biological science needs of Interior bureaus and others by providing scientific information through research, inventory, and monitoring investigations. Biological studies develop new methods and techniques to identify, monitor, and manage fish and wildlife, including invasive species, and their habitats. Scientists inventory populations of animals, plants, and their habitats; and monitor changes in abundance, distribution, and health of biological resources through time. Research and models relating to the impacts of contaminants, land use, climate and other factors help Interior land and resource managers to maintain the health, diversity, and ecological balances of biological resources while meeting public needs, such as game harvests and use of public lands and waters.

USGS is developing a monitoring strategy to determine the ecological effects of the SW Border Fence and associated security activities on desert fauna

USGS specialists also help address resource management problems by providing technical assistance to Interior bureaus and other customers in applying the information, methodologies, and tools developed by the USGS. The USGS collaboratively engages users of scientific information in the identification and prioritization of their information needs during the research planning process. USGS contributes to adaptive management by Interior bureaus, and other customers and partners, where appropriate, are involved in an adaptive process to find solutions and develop new methods by testing research results in the field.

Information Management and Delivery — Science-based decisionmaking is a Department of the Interior priority, particularly as it pertains to the conservation, management, and use of the Nation's natural resources. To facilitate this, the USGS is committed to providing access to the data and information that are critical to scientific discovery and application. Datasets, maps, and other information products are vital to achieve this goal. This subactivity ensures the long-term availability of critical environmental and natural resource data and information generated by USGS and others for scientists, managers, and other decisionmakers, and provides tools for meaningfully interacting with the data. It also provides expertise in standardizing data formats to enable integration of key data aimed at specific challenges such as climate change.

The USGS works in cooperation with many organizations across the country to provide critical information to partners, stakeholders, customers, and the general public. Through electronic infrastructures, the USGS delivers relevant data and information faster and in more usable formats than in the past, leading to better stewardship of our natural resources.

Cooperative Research Units — This cooperative research program allows governmental and nongovernmental entities with common interests and responsibilities for natural resource management to address biological resources issues collaboratively. Through this unique program, biologists from Federal and State governments and academia are able to work as a team and focus their expertise and creativity on the resolution of biological resources issues. This subactivity supports the Department's goal of improving the understanding of national ecosystems and resources through integrated interdisciplinary assessment.

Among many different types of lab work, training new scientists in collecting test samples is an important role of the Cooperative Research Units

Federal support of the Cooperative Research Units program is matched with State and university contributions of expertise, equipment, facilities, and project funding. Through university affiliations, Federal scientists train future natural resource professionals.

Activity: Biological Research

Subactivity: Biological Research and Monitoring

	2009 Actual	2009 Recovery Act [3]	2010 Enacted	2011			Change From 2010 (+/-)
				DOI-Wide Changes [1, 2] (+/-)	Program Changes (+/-)	Budget Request	
Biological Research and Monitoring ($000)	146,416	0	160,685	-3,014	+1,780	159,451	-1,234
Total FTE	*972*	*0*	*998*	*-8*	*+4*	*994*	*-4*

1) $2,164 in fixed costs is absorbed.
2) See the General Statement and Section G for Details on DOI-wide Changes.
3) A new treasury account was created for the Recovery Act appropriations; direct allocations to programs were not made.

Summary of 2011 Program Changes for Biological Research and Monitoring

Request Component	($000)	FTE
• WaterSMART Program	+500	0
• Increasing Resilience to Natural Hazards Initiative	+200	+1
• FWS/NPS/BLM Science Support	+4,000	+16
• Unrequested Congressional Actions	-2,920	-13
TOTAL Program Changes	**+1,780**	**+4**

Justification of 2011 Program Changes

The 2011 budget request for the Biological Research and Monitoring (BRM) subactivity is $159,451,000 and 994 FTE, a net program change of +$1,780,000 and +4 FTE from the 2010 Enacted level. Additional information on program changes is in the Secretarial Initiatives and Mission Increases section beginning on page E-1.

WaterSMART Program (+500,000/ 0 FTE)

Science to sustain aquatic ecosystems — Through the initiative, BRM will provide the biological and ecological science for a coordinated assessment of ecological use, and to accompany hydrological assessments. Water managers require a quantitative understanding of aquatic ecological components and functions to ensure that water is available to sustain fish, wildlife and aquatic ecosystems; to meet current human, and environmental needs; and to adapt to ever growing demands. As society adapts to changes in climate, rural and urban land use, and energy development, water managers need a comprehensive and coordinated approach to obtaining better information on water availability, and human and ecological water use. Building on existing capacities and current research that links precipitation and hydrological changes to biological and ecological responses, USGS will describe aquatic community dynamics, biogeochemical changes, and levels of ecological risk under different water availability and flow

scenarios. Outcomes include incorporation of ecological water use in human infrastructure planning, information for adaptation of fish and wildlife and aquatic systems to future water and climate scenarios, and informed policy and decisionmaking for competing water uses. USGS will coordinate its research with Interior, DOD, NOAA, DOE, USDA-FS, States, Tribes, and other national programs including the *National Fish Habitat Action Plan* and the USGS National Climate Change and Wildlife Science Center to meet the information needs of water resource managers and to ensure that data from the initiative is available in planning for sustainability.

Increasing Resilience to Natural Hazards Initiative (+$200,000/ +1 FTE)

Land managers are troubled by the prospect of wildfires triggered by significant hazard events, such as earthquakes. This potential threat is compounded in southern California, where the high frequency of major earthquakes and the sprawl of human development have created a large wildland urban interface at high risk for post-earthquake fires. However, relatively little is known about fire behavior and the effectiveness of fuels treatments in and around residential housing developments that are draped across highly diverse California chaparral vegetation. Southern California land managers need better information and tools to reduce fire risks to natural and human communities. To meet this challenge, USGS proposes to enhance its modeling capabilities to improve its ability to predict how vegetation, threatened and endangered wildlife species, hydrologic regimes, and other resources will change in response to earthquake-triggered fire disturbances. USGS will work closely with land and resource managers to provide the research they need to respond to the results of a changing climate.

FWS/NPS/BLM Science Support (+$4,000,000/ +16 FTE)

The new funding will support research to increase the scientific information that will be available to FWS, BLM and NPS to inform resource management. Every year, the demand for research to support agency decisionmaking far exceeds the funding available. The additional funding will increase the number of USGS scientists that can work collaboratively with managers and biologists in these bureaus to develop and carry out research projects that address bureau management problems. Current base funding for FWS will be augmented by an increase of $1,500,000, and will include science support for adaptive management, and strategic and tactical research to meet the priority information needs identified by the FWS. An increase of $1,500,000 will be added to programs that support NPS. Projects would include research on climate change adaptation and ecosystem change in parks, and other biological research, monitoring, and technical assistance of high priority to NPS. Support for BLM will be increased by $1,000,000 and will include nonforest fire research and ecoregional assessments of western systems.

Unrequested Congressional Actions (-$2,920,000 / -13 FTE)

The budget reduces five unrequested congressional actions. These projects are not Administration priorities and do not address the highest priority science needs in biology research and monitoring. This will keep the core program intact while allowing the USGS to make the best use of resources. The specific projects are San Francisco salt ponds studies (-$1,000,000), Conte Anadromous Fish Research Lab (-$220,000), general genetics and genomic research (-$750,000), tropical ecosystems and watershed health research (-$600,000) and invasive species protocols in Columbia River Basin (-$350,000) which would eliminate lower priority studies that focus on managing and evaluating wetland restoration.

Program Performance Change

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
1.4: Improve the understanding of National Ecosystems and Resources through interdisciplinary assessments								
% of targeted fish and aquatic populations for which information is available regarding limiting factors, such as migratory barriers, habitat, and effects of disturbance (fire, flood, nutrient enrichment) **(SP) (BRM)**	38.66% (46/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	0	43% (51/119)
% of North American migratory birds for which scientific information on their status and trend are available to inform and improve conservation **(SP) (BRM)**	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	27.1% (176/650)	+0.5%	27.1% (176/650)
% of partners that sought and used science products for species, habitat and land management, and/or regulatory decisionmaking	90.4%	90.4%	90.4%	68%	68%	69%	+1%	70%
Comments	This is quantitatively measured through customer surveys. The description of this measure has been slightly reworded. It previously read, "% of targeted science products that are used by partners for species, habitat, and land management, and/or regulatory decisionmaking."							
# of systematic analyses and investigations completed (BRM)	1,071	931	919	749	749	873	+124	895
Total Projected Cost ($000)	**$214,200**	**$186,200**	**$183,800**	**$157,290**	**$157,290**	**$183,330**	**+210**	**$187,950**

	2007 Actual	2008 Actual	2009 Actual	2010 Plan	2011 Base Budget (2010 Plan + Fixed Costs)	2011 Plan	Program Change Accruing in 2011	Program Change Accruing in Out-years
					A	B=A+C	C	D
1.4: Improve the understanding of National Ecosystems and Resources through interdisciplinary assessments								
Projected Cost per systematic analysis (whole dollars)	**$200,000**	**$200,000**	**$200,000**	**$210,000**	**$210,000**	**$210,000**	**--**	**--**
Comments	Systematic analyses, the product of research, require one to five years for completion.							

Note: Projected costs may not equal program change as these are full costs, which may include funds from other sources and (or) use averages.

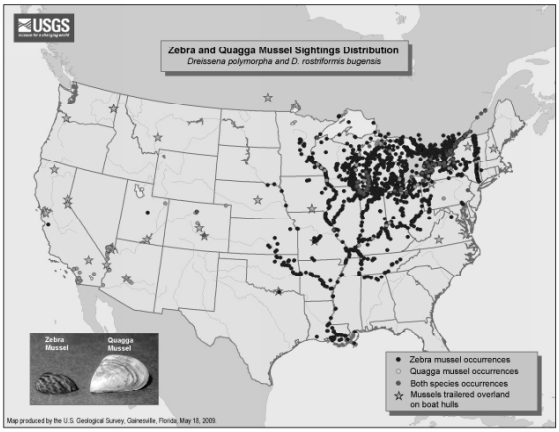
Column A: The level of performance and costs expected in 2010 at the 2011 level plus funded fixed costs. Reflects the impact of prior year funding changes, management efficiencies, absorption of prior year fixed costs, and trend impacts, but does not reflect the proposed program change.

Column D: Out-year performance beyond 2011 addresses lagging performance — those changes occurring as a result of the program change (not total budget) requested in 2009. It does not include the impact of receiving the program change again in a subsequent out-year.

Program Overview

The BRM subactivity conducts research and monitoring that focuses on understanding how ecosystems (diverse communities of living organisms interacting with one another and with the physical and chemical environment) are structured, function, and provide "ecosystem services." This research and monitoring generates specialized information needed to effectively manage and conserve biological resources.

Partnerships — The USGS places a premium on partnerships at all levels of government and with non-governmental entities, including the private sector. The USGS works closely with its partners and customers in defining priorities, developing science plans and standards, and conducting biological research to support the science needs of research management organizations. The research and monitoring information is used adaptively to develop and refine management strategies. Key partners in many of these endeavors include Department bureaus, other Federal agencies, States, Tribes, and private organizations with regional and ecosystem-specific interests. Biological science also supports informed decisionmaking; industrial and agricultural corporations; scientists and academia; and the public.



USGS participates in The Aquatic Nuisance Species Task Force, which coordinates Federal actions related to Quagga and zebra mussels and other aquatic invasive species.

The USGS is a leader in developing a national-level approach to managing biological and natural resource data and scientific information, which ensures the application of standards that foster opportunities for collaboration and cooperation. These partners use USGS-generated

scientific data and information that contribute to the knowledge base, which then become available to Department land and resource managers, and to others.

USGS scientists have played a key role in fostering departmental implementation of adaptive management, a system of sequential, objective-driven decisionmaking in which resource managers learn from and continually adapt their management strategies with new knowledge and findings. USGS scientists were lead authors in producing the Technical Guide for Adaptive Management for the Department. The Guide provides a general framework for adaptive management for Department agencies that can be further tailored as needed to specific agency resource responsibilities and institutional arrangements.

USGS coordinates with the FWS, State and Tribal wildlife agencies, and Canadian and Mexican Federal wildlife agencies, to establish annual harvest limits of gamebirds, such as waterfowl. USGS scientists have developed the population models that are the foundation for these decisions. Migratory bird research includes projects on individual species, communities, habitat relationships, and applied work for effectively managing bird populations.

The following table displays program-funding estimates for three fiscal years for the BRM subactivity.

Biological Research and Monitoring Program Areas (Dollars in Millions)			
Program	2009 Actual	2010 Actual	2011 Estimate
Status and Trends	22.4	22.9	25.0
Contaminant Biology	9.2	9.4	9.2
Fisheries: Aquatic and Endangered Resources	23.9	24.6	23.7
Wildlife: Terrestrial and Endangered Resources	45.1	50.1	50.7
Terrestrial, Freshwater, & Marine Ecosystems	35.0	42.2	40.0
Invasive Species	10.8	11.4	10.8
Total Biological Research & Monitoring	**146.4**	**160.7**	**159.4**

Status and Trends of Biological Resources

http://biology.usgs.gov/status_trends/

(Estimates for 2009, $22.4 million; 2010, $22.9 million; 2011, $25.0 million)

To protect and conserve the living resources entrusted to their care, Federal land and resource managers must first understand the condition, or status, of those resources. Long-term, scientifically sound monitoring of inventory resources provides data on their distribution and abundance over time. The USGS Status and Trends of Biological Resources (S&T) program measures, predicts, assesses, and reports the status and trends of the Nation's biological resources to advance research, facilitate resource management and stewardship, and promote public understanding and appreciation of the Nation's living resources, with emphasis on Federal lands.

Program goals, as outlined in the program's 5-year plan, are to:

- Facilitate integrated monitoring from a variety of sources at multiple spatial and temporal scales to describe and track the abundance, distribution, productivity, and health of the Nation's plants, animals, and landscapes;
- Develop and evaluate inventory and monitoring methods, protocols, experimental designs, analytic tools, models, and technologies to measure biological status and trends;
- Collect, archive, and share critical, high-quality monitoring data in cooperation with partners to determine the status and trends of biological resources; and
- Produce and provide analyses and reports that synthesize information on the status and trends of the Nation's flora, fauna, and ecosystems and be responsive to the needs of the scientific community, land and resource managers, policymakers, and the public.

Breeding Bird Survey — The North American Breeding Bird Survey (BBS) was launched in 1966, utilizing 600 roadside routes to obtain range-wide population data on breeding birds in the United States and Canada east of the Mississippi River. Today, the BBS provides the foundation for non-game, land bird conservation in North America with over 3,200 skilled volunteers sampling 3,000 routes annually across the continental United States and southern Canada. In 2009, USGS received a $1.0 million increase for the BBS for new and increased research and monitoring capacity to better understand large-scale drivers of migratory bird population and habitat change. This initiative has expanded and improved migratory bird monitoring activities and status and trend data critical to the FWS and other partners.

Testing bird detection protocols

Great Lakes — In coordination with the Fisheries: Aquatic and Endangered Resources program, USGS scientists conduct a regional deepwater science, large vessel program that complements other Department activities with large-scale multiyear strategic investigations. The program provides long-term, consistent, lake-wide assessment of forage fish stocks supporting sport and commercial fish species, monitors invasive species for protection and restoration of the Great Lakes, and develops scientific and technological monitoring tools for aquatic species assessment and conservation in the Great Lakes.

Sustainable Energy Development — The Wyoming Landscape Conservation Initiative (WLCI) is a long-term, science-based effort to assess and enhance aquatic and terrestrial habitats at a landscape scale in southwest Wyoming, while facilitating responsible development through local collaboration and partnerships. The WLCI represents the USGS partnership with other Interior bureaus, State and local agencies, industry and private landowners committed to maintaining healthy landscapes, sustaining wildlife and preserving recreational and grazing uses while developing natural gas energy in the Green River Basin. The role of the USGS is to provide the science framework and information for partners to use in making decisions on mitigation, restoration and conservation efforts.

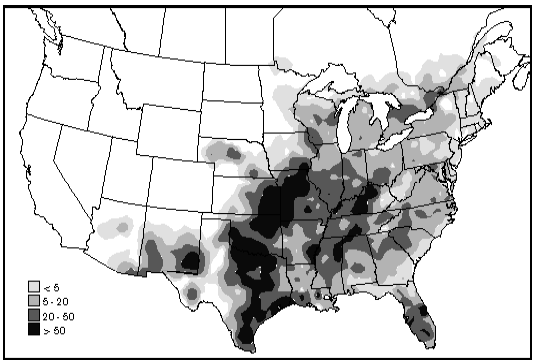
National Park Monitoring — USGS scientists assist national parks with inventory and monitoring protocol development and other monitoring-related research needs such as

assistance with monitoring planning and design, statistical data analysis, and review or revision of existing protocols. USGS scientists and technical specialists address priority issues identified by NPS that typically involve and benefit several parks and require multiyear efforts.

Park-Oriented Biological Support —The USGS and the NPS, through the Natural Resource Preservation Program, jointly support biological projects that provide exploratory research and technical assistance to national parks. The main objective of this project is to support new research on emerging issues that may become significant to the parks, and to develop products useful to the parks.

National Wildlife Refuge Monitoring — USGS is partnering with the National Wildlife Refuge System of the FWS to improve science-based management on refuges. Initially, this project is focused on developing monitoring programs, national protocols, databases and adaptive management studies that address regional and system-wide refuge needs. USGS and FWS are also partnering to support a postdoctoral position to develop a multi-scale, integrated monitoring program for a broad suite of waterbirds across the Atlantic and Mississippi Flyways in the eastern United States.

Bird Banding Laboratory — Bird banding is a universal technique for studying the movement, survival, and behavior of birds. The Bird Banding Laboratory (BBL) provides high-quality banding data in a timely manner for use in developing effective bird conservation and management strategies throughout North America. A Federal Advisory Committee report to the Department and USGS in 2008 helps to guide the future direction of the BBL.



Data from the Bird Banding Laboratory is used to map ranges of species like the Eastern Meadowlark, shown here.

Standards and Protocols — The USGS is a participant in the development of and support for the Natural Resource Monitoring Partnership (NRMP), a collaborative effort by the natural resource management community to improve monitoring efforts to support effective evaluation and decisionmaking. Current participants include State, Federal, and Canadian natural resource management agencies, non-governmental organizations, and academic institutions. To foster coordination and sharing of monitoring efforts, the NRMP provides two collaborative, internet-based tools (*http://nrmp.nbii.gov/*):

- Monitoring Protocol Library — An Internet-accessible, searchable database that provides information on monitoring protocols and resource assessment methodologies organized to facilitate reference and use.
- Monitoring "Locator" — An Internet-based, GIS application that permits users to identify what natural resource monitoring is being conducted within a particular area (e.g., State, province, county or other selected geographical area).

National Fish Habitat Action Plan (NFHAP) — Scientists are investigating research and monitoring issues of highest priority to the NFHAP. Initially, scientists are investigating fish-habitat relationships, including human impacts and their variation at different scales; and standardizing sample design, methodology and monitoring for data analysis.

Sagebrush Ecosystem Research — Populations of the greater sage-grouse have declined significantly in recent decades as a result of habitat loss. The USGS research model indicates that sage-grouse populations are more likely to persist in areas characterized by low population density in 1950 and a higher proportion of sagebrush habitat, and where populations are less isolated. These results suggest that conservation efforts focused on maintaining large expanses of sagebrush habitat, enhancing the quality of existing habitat, and increasing habitat connectivity would be beneficial to maintaining healthy sage-grouse populations. This information will assist Federal resource management agencies assess the status of this species and address conservation needs as they decide whether to list the greater sage-grouse under the Endangered Species Act.

Sage Grouse

Southwest Border Monitoring — DHS and the USGS have partnered to develop a monitoring strategy to provide scientifically credible and defensible data and information to assess the adverse or beneficial effects of security activities on the cultural and natural resources of Border ecosystems. The U.S.-Mexico Border stretches 1,952 miles from the Pacific Ocean to the Gulf of Mexico. Congress directed the U.S. Department of Homeland Security (DHS) to install fencing, barriers, roads, lighting, cameras, and sensors on not less than 700 miles of this border. The Department has trust responsibility for natural and cultural resources along 793 miles (41 percent) of the U.S.-Mexico Border.

Southwest Border Fence

Contaminant Biology
http://biology.usgs.gov/contaminant/
(Estimates for 2009, $9.2 million; 2010, $9.4 million; 2011, $9.2 million)

Appearing with increasing frequency are newly emerging toxicological diseases associated with natural toxicants and anthropogenically derived environmental contaminants, such as endocrine disrupting chemicals, and mercury in fish. Many of these constitute a critical and growing threat to human health as well as the health and function of terrestrial and aquatic ecosystems that are managed by Interior. The emergence of new contaminants and changing patterns of previously identified contaminants within free-ranging populations of fish and wildlife, are frequently driven by human induced changes such as land use alterations, climatic factors, wildlife importation, air and water quality, and geologic factors. USGS has interdisciplinary expertise and capabilities in observing, monitoring, mapping and modeling the ecological, geological, hydrological and environmental factors influencing contaminant related disease occurrence on the landscape. These and other ongoing efforts are enhancing our understanding of the ecological drivers affecting the health of animals, humans and the environment.

The work being done in the Contaminant Biology program is also closely aligned with activities in other USGS Biological Research Discipline programs including the Wildlife: Terrestrial and Endangered Resources (WTER), Invasive Species (Invasives), and the Fisheries: Aquatic and Endangered Resources (FAER), these collaborative activities provide a valuable foundation for

USGS to provide leadership in the broader field of ecosystem health i.e., the ecological context of health.

The USGS Contaminant Biology program provides managers and policymakers with information on the effects of environmental contaminants on ecosystem health and, in particular, the trust resources of the Department of the Interior. Toxicology, chemistry, epidemiology and pathology expertise, cutting edge research, scientific assessments, monitoring tools, and predictive models are used by Interior and other agencies to determine exposure and effects of emerging and legacy contaminants on fish and wildlife. This information helps managers to assess environmental risks, prevent contamination; manage, protect, and restore contaminated lands and trust resources of the Interior; and fulfill recreational, statutory, and regulatory responsibilities.

The Contaminant Biology program continues to strengthen its relationships with existing partners such as FWS and EPA and to reach out to new partners. In 2010 the Contaminant Biology program will be working closely with its State and Federal partners on the development of a new 5-year plan, with a broader focus on ecosystem health and the impacts of climate change, water quality, and other anthropogenic ecological drivers on the distribution and spread of contaminants. Areas of special interest for the program include endocrine disrupting chemicals, intersex fish, immunotoxicology, interactions between environmental contaminants and infectious pathogens, the environmental impacts of nanotechnology, sublethal effects of pesticides and other contaminants on imperiled species, and the development of geographically referenced tools for assessing and predicting changes in contaminant related disease expressions on the landscape.

Bass in some of the headwater streams of the Potomac have a high incidence of intersex characteristics.

USGS scientists are engaged in long term interdisciplinary research to examine the levels of exposure and effects of contaminants that affect immune response, alter reproduction, and influence the endocrine system of free ranging fish and wildlife populations. The information gained is also valuable for enhancing our understanding of the role that the environment plays in public health. In 2009, USGS received additional funding dedicated to the issue of intersex fish and endocrine disrupting chemicals (EDCs). A panel of interdisciplinary experts identified priority research questions and developed a short term research plan which includes a field-based component focused on the effects of EDCs on wild fish populations, laboratory studies to define the mechanistic causes of intersex in fish, and modeling to improve understanding of the effects of EDCs on immune response and genetics of fish. In 2010, the Contaminant Biology program co-led an interdisciplinary effort with the USGS Toxic Substances Hydrology program to develop a national strategic plan to address intersex fish and EDCs.

Fisheries: Aquatic and Endangered Resources

http://biology.usgs.gov/faer/

(Estimates for 2009, $23.9 million; 2010, $24.6 million; 2011, $23.7 million)

The USGS Fisheries: Aquatic and Endangered program conducts biological and ecological research on aquatic species and habitats to determine environmental factors affecting the growth, health, diversity, adaptation and survival of fish and other native aquatic fauna, aquatic communities and aquatic habitats. USGS science on the genetics, life history, behavior, habitat

requirements and limiting factors of aquatic organisms provides the information and methods for aquatic resource managers to restore and manage aquatic populations and their required habitats. Scientific information related to the distribution and habitats of species of concern and the biological integrity of multi-jurisdictional aquatic systems are provided to resource managers to support adaptive management of the Nation's aquatic species and habitats to environmental change. High priority is given to studies that directly assist other Department agencies and national, international, State, and Tribal efforts to manage inter-jurisdictional fishery and aquatic resources in the face of climate change and hazards. The Fisheries Program and the Status and Trends Program support the National Fish Habitat Action Plan, a multi-agency and multi-organization partnership whose goal is to protect, restore, and enhance the Nation's aquatic habitats for fish and other aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people.

Program goals are to:

- Provide scientific information about the diversity, life history and species interactions that affect the condition and dynamics of aquatic communities;
- Provide scientific information about factors and processes that affect aquatic organism health in support of survival, protection, conservation and recovery;
- Quantify and describe functional relationships among aquatic species and habitats to provide information to conserve or restore aquatic community structure, function, adaptation and sustainability;
- Provide science support for natural resource managers by investigating the factors that contribute to the conservation and recovery of aquatic species at risk;
- Develop research and technology tools to provide the scientific basis for developing adaptive management strategies and evaluating their effectiveness for restoration efforts to sustain aquatic resources; and
- Provide research support and technical assistance to Department bureaus, other Federal and State government agencies, Tribes, and non-governmental organizations to support natural resource management problem solving and decision making.

Klamath Basin — Biological Resources and Water Resources scientists are collaborating in the Klamath Basin to determine the effects of changing water availability, water quality, climate, and management actions on population dynamics and required aquatic habitat of important endangered fishes, and on ecological responses in wetlands and the watershed. USGS identified cyanobacterial toxins in Upper Klamath Lake, Oregon where high levels of nitrogen and phosphorus nutrients in the lake facilitate large, continuous cycles of toxic blooms from late spring through the fall. USGS assessed the risk of these toxins to the endangered and culturally significant Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*). USGS is also conducting research related to effects of barrier removal in the Lower Klamath River for restoration of anadromous salmon populations.

High Priority Fisheries Research for FWS — USGS continues to address critical research needs of the FWS in support of imperiled and at-risk species, inventory and monitoring programs, the National Fish Habitat Action Plan (NFHAP), fish passage programs, and fisheries and aquatic resources management. High priority fisheries research for the FWS provided in part by the science support partnership, determined annually by FWS, focuses on fish and other aquatic organism populations in arid and agricultural lands, and in impounded rivers.

Fish Habitat Restoration — USGS has provided science and data leadership for the NFHAP through coordination of the first national assessment of fish habitat in the United States. In

collaboration with the Status and Trends program, Interior, and external partners; USGS develops scientific information and techniques to identify and understand the components necessary for healthy fisheries habitat, and tools and evaluations to inform protection, adaptation and restoration of aquatic communities and fisheries habitat in the Great Lakes. Arctic and sub-Arctic fisheries present special challenges as seasonal extremes limit research opportunities in the field. In 2009 USGS investigated the potential impacts of climate change on the distribution of rare and threatened salmonid species across the western United States, including sub-species of cutthroat trout, bull trout, and Arctic grayling. USGS modeled temperature and flow regimes to predict changes in the distribution of native salmonids and the effect of climate change on other stressors affecting the survival of aquatic species.

Endangered Fish and Aquatic Species — USGS endangered species research provides biological information for restoring currently listed populations, for supporting delisting where possible, or for precluding future listings by clarifying species' status or suggesting preventive actions. USGS has developed watershed-scale identification of Atlantic salmon stocking locations in the Connecticut River using genetic markers and finding that northern stocking locations produced more young fish, but very few adult Atlantic salmon return to northern locations as compared to southern stocking locations.

Fish and Aquatic Species at Risk — Species-at-Risk activities lead to conservation options and actions that reduce the need for listing species as threatened or endangered. USGS scientists led a team of international fisheries biologists in completion of an updated assessment of the conservation status of North American freshwater and diadromous fishes.

Fish Passage and Ecological Flows — Fish passage projects focus on the physiological, behavioral, and hydraulic phenomena that determine the successful navigation of barriers by fish and other at-risk aquatic species and the efficiency of artificial structures designed to allow passage through or around obstacles. Ecological flows projects focusing on determining the quantity, quality and timing of water needed to ensure properly functioning aquatic ecosystems. USGS develops models of fish behavior and aquatic habitat requirements to inform fish passage design, alteration, or dam removal to restore ecological function to managed rivers.

Great Lakes — The Fisheries program coordinates with the Status and Trends program to conduct scientific research in support of interjurisdictional management of the Great Lakes fish and aquatic resources, and facilitates information transfer across jurisdictional boundaries. This information enables ecosystem level adaptive management, conservation, and restoration in the Great Lakes basin. Studies focus on genetics, life history, trophic interactions, health, habitat requirements, and ecology of deepwater and near shore fisheries and other aquatic resources in the Great Lakes and its tributaries. USGS partners within the Great Lakes to determine factors limiting prey fish species that support the Great Lakes fisheries, factors include food web disruption, invasive species and water quality. Research supports the EPA Great Lakes initiative.

Coastal Fisheries — USGS scientists study how coastal and estuarine fish and other aquatic species are affected by changes in their habitat and interactions with other resident and migratory species to provide aquatic resource managers with information needed to conserve and restore important aquatic resources. USGS applies biochemical methods to determine habitat use of Pacific salmon to determine the efficacy of habitat restoration efforts on the estuarine ecology of juvenile salmon in western Alaska.

Fish Biology — USGS fishery research program examines the biology, genetic diversity, and health, all phases of the life cycles of fish and other aquatic organisms, species interactions and their habitat requirements to assist fishery managers who are developing techniques to restore fish populations. Information about declines in marine, anadromous and freshwater fishes in the Arctic and sub-Arctic including Alaska, supports management of fish population for changes in ice regimes, hydrology, biochemical processes, temperature and aquatic community structure.

Fish Genetics — Research in fish and aquatic organism genetics characterizes the diversity, variability, and taxonomic status of individuals, stocks, strains, and populations to enable managers of aquatic resources to identify native, cultured, introduced, and invasive fish and aquatic organisms to develop science-based conservation and restoration strategies. USGS undertakes research to discover possible interactions among environmental contaminants gene expression, reproduction, intersex incidence and fish health problems in key aquatic habitats across the Nation including the Shenandoah and Potomac Rivers.

Fish Disease — Fish disease research focuses on development of new techniques for the detection and identification of emerging pathogens and causative agents, disease resistance and immunology, and understanding the role of stress and environmental factors upon disease outbreaks, severity, and cycles. USGS determines the life histories, hosts, distribution and abundance of native mussels, and identifies how invasive species and degradation of streams, rivers, and lakes are affecting mussel populations.

Large Rivers — USGS research related to water availability and the unique aquatic resources and conditions found in America's large rivers, such as the Colorado, Missouri, Mississippi, and Columbia, is providing vital information on fish community structure and function, aquatic community dynamics and function, critical habitat, hydrology and hydraulics of the rivers, sediments, and water quality. The Colorado River is important for hydropower and recreation, and supports one of only six remaining populations of the federally endangered humpback chub (*Gila cypha*). Information from the USGS Grand Canyon Monitoring and Research Center (GCRMRC) is used by Interior agencies to inform decisions related to the operation of Glen Canyon Dam and the potential effects on downstream resources. GCMRC activities are carried out in collaboration with the Adaptive Management Work Group (AMWG) that includes representatives of Federal and State agencies, Native American tribes, hydropower group, and recreation and environmental interests.

Wildlife: Terrestrial and Endangered Resources (WTER)

http://biology.usgs.gov/wter/

(Estimates for 2009, $45.1 million; 2010, $50.1 million; 2011, $50.7 million)

USGS wildlife research focuses on meeting information needs of the Department's natural resource management bureaus and other partners, as authorized by law. The program conducts basic and applied biological research to determine factors influencing the distribution, abundance, and condition of wildlife populations and communities. Projects develop models of alternative management scenarios to address the needs of adaptive management. Studies also develop tools and methods to prevent and manage disease in free-ranging wildlife and to evaluate the effects of disease on wildlife populations. Investigations link physical, chemical, and biological factors that impact biodiversity and ecosystem resilience through coordinated responses to emerging issues like climate change.

USGS supports recovery of species covered under the Endangered Species Act of 1973, as amended (ESA), and also addresses populations that are declining, but not currently listed. To

help managers achieve their planned recovery goals, USGS scientists investigate species life histories, factors limiting populations, and efficacy of restoration actions. USGS genetics and genomics tools and techniques are growing in importance, and are used in studies of biodiversity, demography, proposals for listing under ESA, contaminant exposure and wildlife disease. Scientists are developing rapid field diagnostic kits, feed-through vaccines and markers.

Cooperative studies among USGS, NPS, FWS, the Southeastern Cooperative Wildlife Disease Study, State natural resource agencies, and the Association of Fish and Wildlife Agencies are helping to determine the causes and impacts of wildlife diseases such as avian influenza, plague, and chronic wasting disease. The program also conducts disease surveillance and responds rapidly to emerging disease, like the recent threats from white-nose syndrome in bats and Chytrid disease in amphibians. Enhancing our understanding of environmental factors in wildlife health also helps to inform human health issues. This work is being conducted in partnership with other Federal agencies, such as the Department of Health and Human Services, Department of Agriculture, and Department of Homeland Security.

Program goals, as outlined in the program's 5-year plan, are to:

- Provide the scientific foundation for the conservation of terrestrial plants, wildlife, and habitats by developing the basic biological information that partners need to formulate adaptive management strategies,
- Provide tools and techniques for effective science-based management, such as predictive models, decision support systems, and expert systems,
- Identify the factors that contribute to or limit the conservation and recovery efforts for terrestrial plant and wildlife species-at-risk,
- Institute an adaptive science approach to support the adaptive management of terrestrial plants and wildlife and provide technical assistance to natural resource managers, and
- Continue to build additional research capabilities, expertise, and to meet the emerging needs of USGS partners as wildlife issues take on new importance in today's society.

High Priority Wildlife Research for DOI — USGS conducts research on species, populations and habitats to support conservation and land use decisions required by FWS and NPS. Increasingly, the focus is aimed at understanding ecosystem function to address cumulative impacts of factors such as climate change, changing arctic ecosystems, and energy development on public lands. In addition to the core program, three complementary subprograms are directed at FWS or NPS needs. Scientific research in these subprograms is primarily short-term in duration.

- **FWS Science Support Partnership —** USGS Science Centers and Cooperative Research Units work collaboratively with the FWS to address FWS mission-critical science needs.
- **Quick Response Program —** This activity addresses short-term research and technical assistance needs requested by the FWS.
- **Natural Resource Preservation Program (NRPP) —** USGS biologists conduct short-term, tactical research to meet the natural resource management needs of the NPS. NRPP funds help fill gaps in applied biological research in the Nation's national parks and allow the USGS to address research needs significant to park resource managers.

Endangered Wildlife and Terrestrial Species — USGS endangered species research provides biological information needed to restore currently listed populations, support delisting

wherever possible, or preclude future listings by clarifying species' status or suggesting timely preventive actions. Genetics and associated tools improve the selection of conservation options, by delineating species and populations, and by assessing their genetic health and viability.

Wildlife and Terrestrial Species at Risk — Species-at-Risk activities lead to conservation options and actions that reduce the need for listing species as threatened or endangered.

Migratory Birds — USGS research on migratory birds are international in scope and are coordinated with the FWS, State and Tribal wildlife agencies, and Canadian and Mexican Federal wildlife agencies. Information from migratory bird research on individual species, communities, habitat relationships, and applied work helps to increase the number and diversity of birds. Molecular biologists have developed new sequence scanning capabilities producing vast numbers of variable markers that can be used to track populations throughout the annual cycle.

Wildlife Disease — Managing wildlife losses and minimizing disease outbreaks depends on effective diagnostic and technical support, knowledgeable guidance, and timely intervention. The USGS has a unique mission to provide information, technical assistance, and research on State, national, and international wildlife health issues such as White-Nose Syndrome in bats, highly pathogenic avian influenza, plague and chronic wasting disease. The infrastructure and interagency partnerships built around wildlife disease are a critical foundation and a template for emergency disease response to future zoonotic diseases of wildlife. USGS will continue partnerships to develop strategies for protecting human, wildlife and domestic animal health.

Little brown bats infected with White-Nose Syndrome

White-Nose Syndrome in Bats - White-Nose Syndrome (WNS), a devastating emergent disease afflicting hibernating bats, has quickly spread from the Northeast to the mid-Atlantic region of the United States, killing more than one million insect-eating bats from at least nine States since 2006. The disease affects hibernating bats in the United States and potentially all temperate regions of the world. WNS threatens both the endangered Indiana bat and the Virginia big-eared bat, in addition to other species. USGS scientists have identified and linked a cold loving fungus to the disease. In addition, USGS is collaborating with the FWS, NPS, and State wildlife agencies on laboratory and field research on the environmental factors influencing transmission and spread. USGS, and its partners are playing an important role in developing national guidelines for WNS surveillance and response activities.

Highly Pathogenic Avian Influenza — In response to the growing threat to human and wildlife health, the USGS has initiated an early detection effort in partnership with FWS, NPS, USDA, CDC and State agencies. USGS tests for the virus in living, and in hunter-killed birds and in association with migratory bird mortality events. These activities are

part of an interagency effort to provide early detection to public health, agriculture and wildlife professionals.

Sylvatic Plague - USGS, along with FWS and NPS, is developing vaccines against plague. Sylvatic affects many mammalian species, including humans. The black-footed ferret is the most endangered mammal in North America; plague is a major obstacle to its recovery. The three prairie dog species upon which the ferret is solely dependent on for food and whose burrows they use for shelter, have been drastically reduced from historical levels, resulting in the near extinction of the ferret. Like the ferret, prairie dog species are highly susceptible to plague and regularly experience outbreaks with devastating losses. The FWS has identified the control of plague outbreaks in prairie dogs and ferrets as vital for ongoing recovery programs and conservation efforts for both species.

Chronic Wasting Disease — The USGS, along with State and Federal agencies, are cooperating on critical research on chronic wasting disease (CWD), a prion disease. Other prion diseases include Creutzfeldt Jacob Disease in people, mad cow disease in cattle and scrapie in sheep. States rely on the USGS for research and technical assistance to help meet the need, USGS scientists study environmental conditions that lead to disease outbreaks, and methods for managing outbreaks. Prions can survive for years in the environment; it is even challenging to decontaminate medical equipment. New USGS cutting edge research on methods for decontamination could have broad scale applications in the fields of wildlife, agriculture and public health.

Amphibian Research and Monitoring — USGS conducts a national program (Amphibian Research and Monitoring Initiative, ARMI) to estimate the distribution and status of amphibian populations on Federal lands, and conducts research to identify the possible causes for their status and potential management actions for their conservation. USGS cooperates with partners in other Federal Agencies, States and academia. USGS scientists are conducting research on the impacts of agricultural practices, water availability, drought, invasive species, diseases, and climate change on amphibian populations on public lands.

New Transmission lines could affect wildlife habitat

The New Energy Frontier-Wind and Solar Initiative — Solar and wind energy research, started in 2010 with $0.6 million, addresses issues faced by Federal and State natural resource agencies related to the placement and permitting of renewable energy sources and transmission lines, and their potential impacts to wildlife species and their habitats. The new funding enables USGS to increase efforts to evaluate and minimize environmental effects of energy development and operation on fish and wildlife habitats.

Arctic Ecosystems Research Initiative — The Arctic Ecosystems Research, a $4.2 million initiative, is a multidisciplinary research program that began in 2010 to enhance biological data collection, modeling, forecasting and molecular biology research. Information from the activity will reduce uncertainty about the future status of ice and permafrost dependent species and their habitats. The new research investigates the relationship between habitats and

ecosystems, identifies species responses to change, creates decision-support frameworks to aid forecasting of physical environment and wildlife responses, improves monitoring of polar bear and walrus, and enhances worldwide predictive capabilities for arctic species. Many of the approaches are also applicable to other latitudes and ecosystems.

Terrestrial, Freshwater, and Marine Ecosystems

http://biology.usgs.gov/ecosystems/

(Estimates for 2009, $35.0 million; 2010, $42.2 million; 2011, $40.0 million)

The USGS Terrestrial, Freshwater, and Marine Ecosystems research program is focused on providing information, models, and tools that managers and others can use to understand how management alternatives will affect ecosystems and the services they provide under a variety of climate, land use, and other change scenarios. Informed forecasting requires that we understand factors controlling the structure, function, composition, and condition of terrestrial, freshwater, and marine ecosystems; their variability in space and time; and the services they provide to benefit human communities and economies. Research results provide the basis for the adaptive management of ecosystems and natural resources, development of forecasting models and decision support tools that integrate ecological knowledge with management options, and development of frameworks and approaches for restoring ecosystems impaired by natural hazards and human actions to sustainable levels. Research activities also focus on understanding ecosystem sensitivity to change and vulnerability to specific stressors, and providing information to mitigate adverse effects on ecosystems and biological communities.

Scientific approaches include studies of ecosystem productivity, food-web relationships and energy flow, cycling of nutrients and other biogeochemical processes, and the diversity of biological communities. Topical areas include the ecology of various ecosystems; disturbances and landscape ecology; modeling ecological systems and quantifying ecosystem services; restoration ecology; fire ecology; and global change. In addition to the scientific community, customers of USGS ecosystem science include land and resource managers and decision and policymakers within the Department and other Federal, State, and Tribal land management and regulatory agencies, as well as NGOs and the public.

The goals of the Ecosystems program include:

- To provide science to sustain and restore ecosystems. In collaboration with others, USGS will quantify, map, and understand ecosystem components and processes, and functions that sustain and restore them across broad spatial and temporal scales;
- To synthesize ecosystem information. USGS will work to make data from its own scientists and partner organizations accessible for adaptive management and forecasting;
- To evaluate ecosystem status and trends. Local and regional monitoring is essential for successful implementation of adaptive management. USGS scientists will strengthen that linkage by tying monitoring tools and efforts to management options and design;
- To forecast ecosystem change and its consequences. USGS scientists will improve methods to forecast ecosystem consequences of climate change, land-use change, chemical contamination, invasive species, fire, altered disturbance regimes, hydrologic alteration, resource extraction, energy development, biodiversity change, and water availability and use; and

- To provide science support to resource management and planning. USGS will develop tools, techniques and interpretive products for managers to protect, restore, evaluate and manage habitats and species using an adaptive approach.

The Ecosystems research program includes the following collaborative areas:

Science on the Landscape — The Science on the Landscape initiative continues to be a successful collaboration between each USGS Region and regional departmental offices. The Department's bureaus have collaborated with USGS in project planning and implementation by leveraging funds or in-kind services to make this venture a true partnership. Although issues vary among regions and Department bureaus, the common theme among all projects is recognition of the Department's priority needs and quick response in providing information to answer questions and issues posed by Departmental bureaus.

Climate Change — The USGS climate change program is an interdisciplinary research program that seeks to develop understanding of the consequences of global change, including climate change and variability, on ecosystems and their component biota and processes. Studies, funded for 3-5 years based on a competitive review process, seek to determine the response of ecosystems and their biological communities to climate change and to assess future global climate and the impacts of climate change on ecosystem services.

Support for Fish and Wildlife Service Landscape Conservation Cooperatives (LCCs) Climate Science — USGS will hire scientists with skills in data management and modeling, climate change, and developing tools to support management and transfer information to users, especially for landscapes that represent management priorities. These USGS scientists will work with others inside and outside the Survey and with natural resource managers to provide the substantial science support required for the LCCs to engage in sustained and well-designed adaptive management projects for dealing with climate- and land-use change.

Coastal Habitats, Wetlands, and Adjacent Uplands — USGS scientists conduct research to investigate coastal (including the Great Lakes) wetland structure and function to assess the resilience of wetland functions and the ecosystem services they provide to natural hazards and human activities, to predict changes in functions and ecosystem services in response to future environmental changes, to determine restoration and sustainable management practices for these systems, and to evaluate the effectiveness of current management actions.

Fire Ecology — The USGS conducts fire ecology research to understand the effects of wildland fire on ecosystem structure and function, and on other ecological attributes such as wildlife habitat. Research is also directed at understanding fire history and fire regimes; interactions of fire with invasive species (e.g., cheatgrass) and climate variability; fire relations with vegetation structure and effectiveness of fuels treatments; and development of guidelines for restoring and rehabilitating fire-impacted ecosystems and watersheds.

Fire in the Everglades

Priority Ecosystems Science in Biological Research & Monitoring — One of the major components of the Ecosystem program is Priority

Ecosystem Science (PES). Research in PES is aimed at improving the understanding of the rates, causes, and consequences of natural and human-induced processes that shape and change the landscape over time and to provide comprehensive information needed to understand the environmental, resource, and economic consequences of landscape change. Through PES, USGS provides integrated science support to better understand the interactive nature of resources and the environment. Additional information can be found in the Science on the Landscape section beginning on page H-1.

Outer Continental Shelf Marine Environmental Studies — USGS research supports the needs of MMS for information on long-term ecological effects of offshore oil and gas exploration and production, including effects of active and decommissioned production platforms, of sand and gravel dredging activities for beach nourishment, on fish and deep sea corals, and on the condition, composition, and vulnerability of biological communities in areas of potential or new production or dredging.

Coral Reefs — USGS conducts research on issues facing resource managers, including understanding conditions needed for productive and healthy reef communities, effects of land use on reef health and disease in support of the Coral Reef Task Force, and evaluating management options for human activities and how they influence reef integrity and biodiversity.

Rangelands and Grasslands — USGS conducts studies on native grasslands and managed rangelands to assess ecosystem condition, determine spatial patterns of rare plants, and evaluate native plant diversity and species richness as impacted by past management, invasive species, and climate change.

Deserts and Arid Lands — In the Southwest, USGS scientists are investigating the history and effects of changes in patterns of temperature and precipitation on desert grasslands and shrublands, and mountainous ecosystems. Investigations of the effects of natural and human disturbances on discrete soil units and the biota they support are studied in the context of current and predicted large-scale changes.

Prairie Wetlands — USGS researchers are investigating factors influencing the use of restored wetlands by birds, amphibians, and macroinvertebrates, and quantifying recovery of non-wildlife functions such as sedimentation, greenhouse gas emissions, and the role of prairie pothole wetlands in sequestering carbon. Research is also conducted at a landscape scale on wetland processes, including the interactions of wetland biota with hydrology, geochemistry, and sedimentation in fragmented grassland landscapes.

Forested Wetlands — USGS research focuses on wetland regeneration and restoration in the southeastern United States, including site selection and preparation; forest mix and biodiversity enhancements; planting and community structure; management procedures and monitoring providing information for managing forested wetland flora and fauna and to quantify the role forested wetlands play in nutrient cycling and retention and in carbon sequestration.

Forest Ecosystems in the Pacific Northwest — USGS research focuses on healthy forest management in the Pacific Northwest, including understanding forest systems, sustaining biodiversity and ecosystem function, developing resource management options, recovery of sensitive and status species, supporting management of aquatic forest habitats, conducting landscape scale assessments, and addressing forest stressors such as climate change, fire, and pathogens.

Invasive Species

http://biology.usgs.gov/invasive/

(Estimates for 2009, $10.8 million; 2010, $11.4 million; 2011, $10.8 million)

Non-indigenous invasive plants and animals cause increasing harm to native species and significant economic losses by reducing productivity and diminishing opportunities for beneficial uses of forests, croplands, rangelands, and aquatic resources. Many species introduced decades ago have spread rapidly in U.S. ecosystems and pose increasing threats to lands and waters managed by the Department of the Interior. They harm native ecosystems and are "contributing factors" in the listing of 40 percent of threatened and endangered species. The economic costs associated with invasive species are estimated to exceed $100.0 billion per year.

USGS plays an important role in Federal efforts to combat invasive species in natural and semi-natural areas by providing information on early detection and assessment of newly established invaders, monitoring invading populations, improving understanding of the ecology of invaders and factors in the resistance of habitats to invasion, and development and testing of prevention and alternative management and control approaches.

USGS plays a significant role in implementing the National Invasive Species Management Plan (Plan), developed by the National Invasive Species Council, as called for in the Presidential Executive Order on invasive species. To meet the goals of the Plan, the USGS Invasive Species program provides management-oriented research and delivers information needed to prevent, detect, control, and eradicate invasive species and to restore impaired ecosystems. USGS researchers are leading or cooperating in efforts to integrate the capabilities of the USGS and partners, including Federal and State resource agencies, to help provide the information, methods, technologies, and technical assistance needed for effective responses to terrestrial and aquatic invaders threatening U.S. ecosystems and native species.

An important focus is on developing forecasting and predictive modeling tools by synthesizing and disseminating data and research to help detect and predict the effects of harmful invasive plants and animals. Recent examples of this work include predicting the potential range of Didymo, an invasive species of algae, and predicting the effects of climate change on the distribution of kudzu. USGS hosts the National Non-indigenous Aquatic Species Database, which provides the latest information on the distribution of introduced aquatic species around the Nation. The publicly available online database contains illustrated fact files on the species' biology, capabilities to interactively map sightings, and email alerts when a species is sighted in a geographic area. It is a primary source of invasive species information and early alert system for managers and the public with over 26,000 visits per day. Species of particular concern recently have included Asian carp, zebra mussels, quagga mussels, and lionfish. Researchers are also developing strategies and techniques to facilitate the restoration of native species and habitats in areas invaded by species such as tamarisk, cheatgrass, leafy spurge, buffelgrass and yellow star thistle.

Program goals, as outlined in the program's 5-year plan, are to:

- Conduct research and develop methods and technologies to prevent the introduction of invasive species;
- Identify and report new invasions and assess risks to natural areas and waters;
- Assess changes in populations and distribution of established invaders;
- Determine effects of invasive species and susceptibility of habitats to invasion;

- Provide approaches to contain, reduce, and eliminate populations of invasive species and restore habitats and native species; and
- Provide and coordinate the collection, synthesis, and accessibility of invasive species information.

The Department's bureaus work in partnership with other Federal agencies; State, local, and tribal governments; and private sources to conduct activities related to prevention, early detection and rapid response, control and management, restoration, and organizational collaboration.

Hawaiian Invasives — USGS research focuses on the ecology and control of highly invasive plants (e.g., miconia, faya tree, strawberry guava, Kahili ginger), including exploration and testing for biological control agents; animals (e.g., Argentine ant, mouflon, brown tree snake on Guam); wildlife disease organisms; and methods for reducing the impacts of invasive species on the region's unique native flora and fauna.

Weeds in the West — USGS conducts a multiscale, integrated program for mapping infestations and accurately monitoring the spread of invasive plants (i.e., weeds) in western forests and rangelands, improving methods for predicting areas most vulnerable to invasions, and assessing the effects of management practices and natural disturbances on invasions. The USGS assesses the effects of invasions on ecosystems and native species (e.g., fire ecologists determine how invasive species alter the frequency and intensity of wild fires); and provides improved methods for reducing the adverse impacts of invasive weeds and for restoring public range lands affected by weed invasions

Invasives in the East — USGS conducts research on invasive species that threaten ecosystems and native species in the eastern United States including terrestrial and aquatic surveys of non-indigenous species in eastern parks and wildlife refuges, studies of pathways for establishment and spread of invasive species, research on the impacts of invasive species and factors in invasions, and development of methods to control or eliminate invasive species to promote healthy native communities that are resistant to invasion.

Great Lakes Invasives — USGS research supports cooperative efforts in the Great Lakes region to prevent and control the spread of invasive fish, such as the round goby sea lamprey and Asian carps, reduce the pervasive impacts of zebra and quagga mussels on U.S. waterways, and manage or mitigate the adverse ecological and economic impacts of the invaders. USGS research also supports the development of novel techniques and methods to control aquatic invasive species.

2010 Program Performance

The USGS serves the biological research needs of Department bureaus and others by providing scientific information through research, inventory, and monitoring investigations.

Webinar Short Courses for Natural Resource Managers — Natural resource managers often lack the time and travel funds for in-service training outside of their office setting. Recognizing the need for this training, the USGS Status and Trends program developed a series of “Webinars”, Web-based courses that could be taken at the managers’ individual workstations. In 2009, the courses enabled over 2000 individuals from Interior bureaus, U.S. Forest Service, Tribes, universities, State and local agencies, and elsewhere to receive much needed training

on statistics, modeling, surveys and adaptive management topics that are critical to their jobs in natural resource management. Course offerings were expanded in 2010.

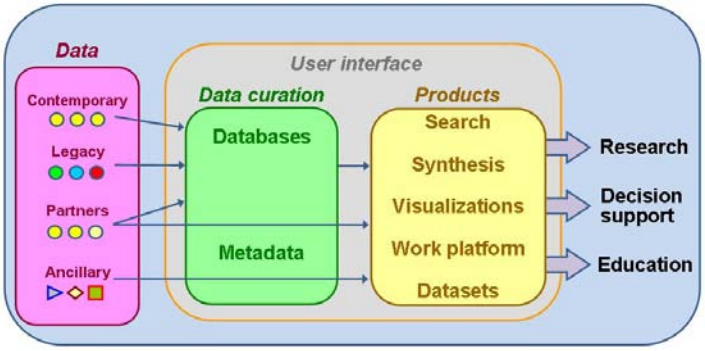
Tracking Invasive Aquatic Species — The USGS National Non-indigenous Aquatic Species Database (NAS), provides the latest information on sightings of introduced aquatic species around the Nation. The publicly available online database, hosted at the Southeast Ecological Science Center, contains illustrated fact files on the species' biology, capabilities to interactively map sightings, and e-mail alerts when a species is sighted in a geographic area. It is a primary source of information and early alert system for managers and the public with over 26,000 visits per day. Species of particular concern recently have included Asian carp, zebra mussels, quagga mussels, and lionfish. In 2009, researchers entered 7,350 records into the database, added five new species, and sent out 194 email alerts. In 2010, NAS will continue to provide updated data on the distribution of introduced species to natural resource management agencies and organizations from across the United States and internationally. Maps and information provided by NAS have appeared in *The Wall Street Journal*, *The New York Times*, and on CBS.

Imperiled Native Freshwater Species Research and Database — The USGS conducts research on imperiled aquatic species. In partnership with the American Fisheries Society (AFS), the USGS Southeast Ecological Science Center (SESC) developed and hosts the Imperiled Freshwater Organisms of North America database, which serves data on the distribution, status and threats to native imperiled freshwater species. In 2009, SESC researchers reported the decline of native North American freshwater fish and added important new information on the status of imperiled native crayfish to the database; imperiled native mussels and snails followed in 2010, and will continue into 2011. State and Federal agencies, nongovernmental organizations, and the public rely on the accuracy of the database for managing these species. USGS and university scientists published multiple peer-reviewed journal articles concerning imperiled aquatic species status and management.

Characterize Intersex in U.S. Fish — The presence of male and female gonad tissues in the same individual, known as intersex, is a troubling phenomenon that has been reported from many locations throughout the United States. USGS scientists have published the first comprehensive U.S. survey of intersex in fish. Intersex has been a public concern due to linkages of this condition to the release of endocrine disrupting chemicals into the environment. Intersex was found in approximately one-third of the sites monitored; much greater than anticipated. In 2010-11, USGS is conducting studies to understand the environmental (ie. temperature) and chemical factors that cause this condition, to develop diagnostic tools, and to determine population-level impacts of intersex in fish. Trust resources of the Department have this condition, yet USGS cannot currently diagnose the causal agents or suggest management strategies for resource managers. USGS findings and current studies will help systematically address this topic for the Department.

National Phenology Network — USGS established and coordinates the USA National Phenology Network (USA-NPN), a collaborative effort among scientists, resource managers and the public to track the effects of climate change on plants and animals across the Nation. Phenology is the study of the timing of seasonal events of plants and animals, such as flowering, fruiting, egg-laying, migration. This information is used in ecological forecast models for agricultural production, management of invasive or pest species, monitoring of drought, and predicting wildfires and human health hazards. USA-NPN has an interactive Website that provides standards for monitoring phenology of plants and animals, tools for reporting and analysis of data provided by a variety of users, and services for storing and searching historical

phenology datasets that provide a baseline for understanding contemporary and future environments. NPS and FWS will use USA-NPN monitoring standards, and in many cases the user interface and database for entering and storing data, as part of their inventory and monitoring and education/outreach programs. Other partners include other Federal agencies (e.g., NOAA, NASA), non-governmental organizations (e.g., The Wilderness Society, The Wildlife Society), educators, Native American Tribes, educators, academics and the American public.



The USA National Phenology Network (USA-NPN) maintains a comprehensive user interface to serve data and share Information related to the timing of seasonal events of plants and animals. The USA-NPN information management system collects, stores, and disseminates data and provides products to interpret phenology-related information. Scientists, resource managers, policy-makers and the public use this information for research, decision support, and education activities.

The Salt Cedar and Russian Olive Control Demonstration Act of 2006 (Public Law 109-320) — directs the Department of the Interior to submit a report to Congress that includes an assessment of several issues surrounding these two nonnative trees, now dominant components of the vegetation along many rivers in the Western United States. This report was published in December 2009, as a USGS Scientific Investigations Report. The report was produced through a collaborative effort led by BOR and USGS, with critical contributions from various bureaus within USDA and from university researchers. The document synthesizes the state-of-the-science and key research needs on the following topics related to management of salt cedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) in the western United States: their distribution and abundance (extent); the potential for water savings associated with controlling these species; considerations related to wildlife use of salt cedar and Russian olive habitat and restored habitats; methods of control and removal; possible utilization of dead biomass following control and removal; and approaches and challenges associated with site revegetation or restoration following control and removal. A concluding chapter discusses possible long-term management strategies, potentially useful field demonstration projects, and a planning process for on-the-ground projects involving removal of salt cedar and Russian olive.

Greater Yellowstone Ecosystem - Snake River Project — The Snake River Priority Ecosystems Science project is part of the Greater Yellowstone area (Yellowstone National Park and Grand Teton National Park), which includes multiple States and mixed jurisdictions of Federal, State and private lands. The area is home to relatively intact species assemblages that represent world class wildlife, botanical, and geologic resources. These resources will be affected with competition over potential uses, including urbanization, mineral development, recreational use, and traditional land use such as grazing and timber harvest and also by climate change. USGS's work, in coordination with other Interior agencies (BOR, FWS, and NPS), State (WY) and nongovernmental organizations has resulted in the formation of a science advisory panel to identify the issues and information needs of this area to adaptively manage these resources. Accomplishments to date include: information on riparian and geomorphic relationships provided to the NPS, which has been used in developing the monitoring plan for the Greater Yellowstone area; information provided to NPS and BOR to address modifications to river flow, to more closely mimic natural seasonal water flows thereby providing an opportunity to adaptively manage the system; and development of a Structured Decision-Making model initiated.

Program Performance Overview

BRM addresses the Department of the Interior's goal of improving the understanding of national ecosystems and resources through integrated interdisciplinary assessment and by providing the science information that resource managers need. The following table highlights important performance measures for BRM:

End Outcome Goal 1.4: Improving the understanding of national ecosystems and resources through integrated interdisciplinary assessment

End Outcome Goal End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
End Outcome Measures										
% of partners that sought and used science products for species, habitat, and land management, and/or regulatory decisionmaking science products that are used by **(SP)**	A	86.9%	90.4%	90.4%	67%	90.4%	68%	69%	+1%	70%
Comments	This is quantitatively measured through customer surveys. The description of this measure has been slightly reworded. It previously read, "% of targeted science products that are used by partners for species, habitat, and land management, and/or regulatory decisionmaking."									
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of North American migratory birds for which scientific information on their status and trends are available **(SP) (BRM)**	A	26%	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	26.6% (173/650)	27.1% (176/650)	+0.5%	27.1% (176/650)
% of targeted fish and aquatic populations for which information is available regarding limiting factors **(SP) (BRM)**	A	31%	38.66% (46/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	41% (49/119)	0	43% (51/119)
% of targeted invasive species for which scientific information and decision support models are available to improve early detection (including risk assessments) and invasive species management **(SP) (BRM)**	A	51.6%	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	54% (3.25/6)	0	54% (3.25/6)

End Outcome Goal End Outcome Measure / Intermediate Measure	Type	2006 Actual	2007 Actual	2008 Actual	2009 Plan	2009 Actual	2010 Plan	2011 Plan	Change from 2010 Plan to 2011	Long-term Target 2012
Intermediate Outcome Measures and Bureau and Outcome Measures **Ensure availability of long-term environmental and natural resource information, data and systematic analyses needed by land and resource managers for informed decision making**										
% of studies validated through appropriate peer review **(SP)**	A	100% (1067/ 1067)	100% (1071/ 1071)	100% (931/ 931)	100% (748/ 748)	100% (919/ 919)	100% (749/ 749)	100% (873/ 873)	-	100% (895/ 895)
Efficiency and Other Output Measures										
# of systematic analyses & investigations completed **(BRM)**	A	1,067	1,071	931	748	919	749	873	+124	895
Total Projected Cost ($000)		**213,400**	**214,200**	**186,200**	**157,080**	**192,990**	**157,290**	**183,330**	**+26,040**	**187,950**
Projected Cost per systematic analysis (whole dollars)		**200,000**	**200,000**	**200,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**	**210,000**